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WORTHLESS GOVERNMENT ENGINEERING.

By George Y. Wisner, M. Am. Soc. C. E.

THE improvement of water-ways and deep-water harbors, so as to accommodate the increasing commerce of the country, has been ably discussed recently by legislators and professional experts. While the unanimous conclusion is that the results thus far obtained are very inadequate, the reasons for the failures of the works undertaken have not been made sufficiently clear to convince Members of Congress of the remedy that should be applied in order to correct the evil.

Congress has appropriated annually a large amount of money for the education and support of a Corps of Engineers to whom have been confided the entire control of the improvement of rivers and harbors, and the disbursements of the large appropriations made for that purpose. The failure of this Corps to accomplish what the public has hoped for from the means placed at their disposal may to a certain extent arise from defective legislation, but the principal cause undoubtedly is to be found in their methods of conducting work over which they have full control.

The officers of the Corps admit that the works they have designed and undertaken to construct, in a majority of cases have failed to produce any beneficial results. At the same time they claim that their methods and plans have not been defective, and that the dilatory manner in which appropriations have been made by Congress has rendered the successful completion of the improvements impossible. It is true that with insufficient funds for its rapid prosecution work becomes much more expensive, and in

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exposed localities is often subject to great deterioration when left in an incomplete condition. At the same time a careful examination of the various enterprises that have been undertaken by the Corps can but convince the unbiased investigator that with unlimited funds the results would have been the same. The Army engineers are well aware of this, and while charging that Congress is responsible for their failures, they apparently are not anxious to be relieved of the evil of which they complain.

During the last session of Congress, when a bill granting $6,200,000 for the improvement of a certain harbor was being discussed by the Senate Committee on Commerce—for which improvement the officer in local charge estimated that $2,350,000 could economically be expended during the fiscal year—the Engineer Department requested that a clause be incorporated in the bill limiting them to an expenditure not to exceed $1,000,000 per annum. Such action shows a want of confidence in their plans that on a private enterprise would cost the engineer his position, and indicates a questionable desire for an opportunity to shift responsibility in the case of failure.

Appropriations amounting to millions have been expended in various harbors where the works so far as completed show no amelioration of the original condition, and what is still worse, indicate that the expenditure of any additional amounts under the same plan would produce no better results. The negative result of the harbor works at Charleston, S. C., is typical of the condition of affairs at most of the harbors on the South Atlantic, Gulf and Pacific coasts, where it has been attempted to improve the channel entrance. In the last annual report of the Chief of Engineers it is estimated that $3,132,000 will be required to complete the improvement in Charleston harbor in accordance with the plans adopted in 1878. The estimated cost at that date was $1,800,000, and $2,203,500 has already been expended upon the work. According to the latest charts of the harbor the average depth of water on the bar is approximately the same as in 1878. Since jetties, however far completed, should produce the same effect through section of channel between them as when carried to any greater distance seaward, it is evident that to continue the work under the present plans will be a deliberate waste of public funds.

Previous to 1883 the Army engineers expended $1,578,000 in attempts to deepen the channel across the bar at Galveston harbor, which resulted in a total improvement in depth of only one foot—

a rate of increase in depth at which it would require 340 years to complete the improvement desired. Captain Eads, at the request of the citizens of Galveston, made an examination of the harbor and offered to enter into a contract to obtain a permanent thirty-foot channel across the bar and guarantee results for the sum of $7,750,000. This project the Army Corps succeeded in defeating. They have since formulated a plan for the improvement, which they have estimated to cost $7,000,000, but which, under the contract recently let, will require at least $9,000,000 to complete. Thus, it is evident that the Government will be required to expend $1,250,000 in excess of the amount necessary to have a permanent channel guaranteed in order to allow the officers of the Corps to experiment with plans which scarcely one reputable civil engineer believes will succeed.

A distinguished Senator recently said in regard to this matter: "I am not entirely satisfied with the reports of the engineers as to the work done there. They have made some terrible mistakes, and have thrown away a large amount of money, and I would not be surprised if it turns out that we shall be compelled to adopt some other place hereafter and some other plan." Another Senator in the same discussion said: "The Engineer Corps know that they are to go on and on, and it does not make a cent's difference whether they spend the money wisely or not. Their salaries are assured, their proportion of the money is bound to come, and they perform their work with a recklessness and an entire disregard of the responsibilities of the situation, such as would not be tolerated in any other country in the world. But we tolerate it and seem to enjoy it." The question naturally arises why do they tolerate it? If Congressmen believe, as they say they do, that the Corps have failed totally to fulfill the purposes for which they exist, why not blot the system out of existence and inaugurate one of conducting public works based upon business principles?

There is another feature of the system of conducting business by the Corps which is even more discreditable than their failures. Officers interested in obtaining appropriations for certain harbors do not hesitate to advocate personally the measures before committees in Congress, and at the same time disparage other ports, often more advantageously situated for advancing the commercial interests involved. This has been carried to such an extent that statements have been made to Congress that the facts often would not warrant, and that too, in cases where large lobby funds were

being expended to secure the passage of the measure. Congress in 1880 undertook to infuse new life into the Corps by placing the improvement of important rivers under the supervision of a mixed commission of military and civil engineers. The bill was so manipulated, however, that the military element is in a majority, which practically leaves the management of affairs under the direction of the corps. The result is that there is general dissatisfaction throughout the entire river valley over which they have jurisdiction, and a conviction among those most interested that but little benefit can be hoped for from the large annual expenditures of the commission, until more satisfactory methods of conducting the work are adopted. Expensive systems of triangulation have been carried from the head waters of the Missouri to the Gulf of Mexico, without any regard as to whether the work was a necessity or not, and, it is asserted, hundreds of square miles of detail topography filled in on the charts by *guess and officially stamped as correct.* If these charts should have the misfortune to be preserved for the examination of the engineer of some future age, he will be unable to account for the changes in topography along the upper Missouri except by some such convulsion of nature as that which in past ages changed the outlet of the great lakes from the Mississippi to the St. Lawrence.

Some years ago a member of the Corps, under the *nom de plume* of "John Phenix," wrote some very amusing sketches of the methods of conducting work by officers of the Corps. Unfortunately these articles had more truth than fiction for a basis, and what was then considered a good joke, has to-day become a serious obstacle to the advancement of the commercial and industrial interests of the country. To spend weeks determining the volume of discharge of a river, as was recently done by a young officer, and then correct the result 20 per cent. from information given by citizens as to stage of water in former years, may be highly satisfactory when such a result is desired, but can hardly be considered sufficiently trustworthy data upon which to base the improvements of an important stream.

A mattress dam was recently built across the mouth of Red River to prevent the water from the Mississippi River, during floods, from escaping through that outlet, but after the work was completed the engineers discovered that at low water it would be impossible for steamers to climb over the dam, and, therefore, had a channel *dredged* through the obstruction for navigation purposes.

This item, I understand, is omitted in the annual report of the engineer.

The red-tape system of the Army Corps requires that authority be obtained in advance for all expenditure, and consequently, in cases of emergencies, losses frequently occur from want of prompt action. A few years ago the Government plant at the mouth of the Saginaw River caught fire, and would have been destroyed but for the services rendered by a private tug, the vouchers for which were disallowed by the Department for the reason that no authority had been obtained for the expenditure.

In civil life important positions are so generally secured by engineers of superior intelligence and experience that it seems a strange anomaly to find public works, on the success of which the commercial welfare of the country largely depends, placed in the charge of men who have little or no knowledge of the requirements except as obtained from their assistants. It is no uncommon occurrence for these so-called assistants to be called before the officer in charge and questioned as to what should be done in certain matters of examination or construction, and the following day receive written detail instructions how to do the work, made up from the previous day's interview. No matter what facts may be developed in any enterprise, no assistant is allowed to publish any statement without the sanction of the officer in charge, and in fact not even officially report results that are not in harmony with the pre-conceived ideas of the Department. During the past year an assistant of ability and long experience was summarily dismissed from the service for simply incorporating in his annual report a statement of the results obtained from certain harbor work, which was not what the members of the Corps had predicted, and of which they preferred that the public should remain ignorant.

It is claimed on the part of the Army Corps that no other class of individuals have the training and executive ability necessary to honestly and economically disburse the large river and harbor appropriations. If this is true it would be interesting to know what they consider executive ability to consist in, for under the present order of affairs their duties amount to but little more than that of disbursing clerks. The designing of labor-saving plant and the handling of large forces on harbor construction is almost entirely done by the contractors and civil engineers who execute the work, while the duties of the officer in charge, whose office is often hundreds of miles from the seat operations, usually consist in inspecting

the work by proxy and signing checks for payment of monthly estimates of work done. The inspection of works constructed under contract is often placed under the supervision of inexperienced men who in many cases make themselves either obnoxious by unnecessary requirements, or for pecuniary considerations allow work of an inferior character to be done. Appeal to the officer in charge in the case of unjust decisions on the part of inspectors, is of little avail, for in most cases he has no practical knowledge of the requirements, and will not take the trouble to inform himself personally as to actual character of work done. If contractors could have honest and competent engineers in direct authority to deal with, there would be neither the opportunity nor incentive on their part to do work such as of late years has brought our public works into so much disrepute.

In awarding contracts for constructing public works it is very essential that the specifications should be clearly and accurately drawn, not only as to the manner in which work is to be conducted, but with due regard to the material to be used, and whether it can be obtained in the vicinity of the work at reasonable cost. In a contract recently awarded, involving millions of dollars, the specifications were so blindly drawn that the officer in charge was unable to interpret its requirements.

The manner of awarding the contract for the construction of a light-house at Diamond Shoal reef is an example of professional cowardice without parallel in the annals of American engineering. The Light-House Board, composed of men educated and supported by the Government for the purpose of designing and conducting such works, completely shift all responsibility in the matter, and require the contractor to made his own survey and location, make designs, furnish material and construct and maintain the light for one year before receiving any compensation, and besides this, give a heavy bond for the successful accomplishment of the enterprise. Why a bond guaranteeing success in an undertaking in which the Government has no responsibility should be required, is a conundrum that but few outside of the corps can answer.

From causes, such as above mentioned, nearly all improvements conducted by the Army engineers are unnecessarily expensive, whether done by contract or otherwise. The writer recently had charge of opening a deep-water port on the Gulf of Mexico which the Army engineers had previously undertaken to improve, and failing to obtain any satisfactory results, had abandoned as im-

practicable. The material for construction in both cases was obtained from the same source, and yet the cost of construction per cubic yard, under the direction of the Engineer Corps, was *six times that of the private enterprise.* There is no reason for such a waste of public funds, except a lack of practical knowledge of construction which, in civil life, would effectually debar any engineer from securing charge of work.

During the past twelve years several attempts have been made to reorganize the corps and institute a reform in the method of conducting the public works of the country, but without accomplishing any beneficial result beyond awakening a more general interest in the urgent necessity for some such action. This effort at reform, however, has shown that the bad features of the system are to a great extent the source of its permanency.

No general reform of the magnitude contemplated can be accomplished without the active co-operation of the press. At present, while nearly all reputable journals admit the advisability of reorganizing the corps, they seem to find it to their interest to say but little on the subject. The demand for improvement of harbors and water-ways has become so general that there is scarcely a section of the country that does not have a direct interest each year in some item of the river and harbor bill that would be jeopardized by opposing the method of conducting public works by the Army engineers. No matter whether a project is worthy or not, the citizens of each locality look upon the expenditure of an appropriation as a local benefit, and bring every possible influence to bear in order to obtain it.

It is also hinted that the managers of some technical journals, whose main support comes from civil engineers, and whose interests they should represent, do not give the matter the support they should, for fear of losing their columns of profitable Government advertisements. At least their advocacy of reform has generally been of a very mild character, and without any reference to the main evils of the system. Members of Congress generally do not hesitate to express their want of confidence in the Corps, and disapproval of their method of conducting work, yet are averse to taking any official action to place public improvements on a better business basis, for the reason that their constituents expect them to secure the usual appropriations for their districts, which can only be done by supporting the river and harbor bill as prepared by the Engineer Department.

Reform from within the Corps is also equally hopeless, for under its military rules it is a breach of discipline for a junior officer to criticise the opinions of a superior, and consequently it does not matter what ability individual officers may have, it is impossible for the Corps as a body to extricate themselves from the rut they have for years been working deeper and deeper into.

The recent National Board of Visitors to West Point found that the instructors there in French and Spanish could not speak those languages, and that the instructors in the sciences were young graduates of the institutions detailed temporarily for that purpose. The Board recommended that experts from civil life be appointed to these positions, but with the well-known opposition of the corps to such measures, it is safe to say the recommendation will never be carried into effect.

The so-called *esprit de corps* of the Army engineers has degenerated into a sort of nepotism, such that of the five positions in the Corps, that in compliance with law should be filled by civilians, two have been given to sons of West Point graduates and one to a retired Army officer. The appointments have been made for the remaining two vacancies, probably for lack of proper material of the same character. No candid investigator can examine the history of our public works for the past twenty years without coming to the conclusion that the practice and method of the Engineer Corps are a disgrace to the nation, and an outrage upon every practising engineer in the country. Their inefficiency is beyond question, and their waste of public funds forms a formidable obstacle to the progress of our most important commercial and industrial enterprises.

THE WORLD'S STORE OF TIN.

By E. W. Claypole, B. A., D. Sc.

THE metals with which man first became acquainted doubtless were gold and silver. Found usually and in some places abundantly in the metallic state, they attracted the eye and the fancy of even the savage and were employed by him for purposes of ornament. No other metals equal these in beauty or native purity. Copper was probably the third to be enrolled on the list of the metallic resources of man. It is found native on both continents and the records of history on the Eastern and the traces of ancient mining in the Western world prove the great antiquity of man's knowledge and appreciation of this metal. But to early man copper alone was of little use. Inferior in beauty to gold and silver and too soft to hold an edge, it found little scope for usefulness. There probably was a time, in the old world at least, when it served a few purposes for which strength and a cutting edge were not the chief requisites, and in America copper beads and similar traces of the metal are not rare. But not until tin was discovered did the full value of copper appear. This was at an early period, however.

Tin was known so early in the Eurasian continent that the date and mode of its discovery are lost. At the dawn of history we find it in use among a few favored nations and its source jealously guarded. The Phœnicians, thirty or forty centuries ago, were familiar with it and with the hardness of its alloy with copper. Accordingly Phœnicia appears to have been the bronze* market of the ancient world. They obtained the copper probably from Cyprus, and possibly elsewhere, for the ore is widely diffused and the Phœnicians doubtless extended their voyages to the East Indies. But tin ore is confined within much narrower limits. The metal occurs in many places, but in very few which could have been known and reached by the Phœnicians. Their fleets went to Spain and there are old tin mines in that country from which, especially those near Carthagena, they may have drawn some of their supply. However, as they went to the East Indies they may have first become acquainted with the abundant but long-forgotten supplies of that

*The word translated "brass" in ancient literature should be read "bronze," as the former metal, an alloy of copper and zinc, was unknown till recent times.

rich and fabulous region. But it is far more probable that this adventurous people drew most of their tin, as they certainly drew some of it, from Cornwall. Traces of Phœnician presence are not lacking in that county, and early historians testify to the old intercourse between the Britons and merchants from Gaul in quest of this precious metal.

There is little room to doubt that the tin employed by Hiram of Tyre in the building of the temple for King Solomon, about the year 1000 B. C., was brought from Britain, and the way in which it is mentioned indicates an abundance of the metal.

In Europe tin-ore is found, in Spain, Saxony, Britain, Italy, Portugal and Russia. But of these only the second and third yield any appreciable amount. In Asia it occurs in the Straits Settlements (Malacca) and Japan. It is also present in Dakota, California, Peru, Victoria, Queensland, Tasmania and New South Wales.

Only one ore of tin has any economic importance. This is cassiterite,* or the compound of one part of tin with two parts of oxygen. It is the stannic acid of the chemist, a black, heavy, hard and brittle mineral which, if perfectly pure, as is seldom the case, yields 78.7 per cent. of metal. Occasionally very beautiful crystals are found, transparent or yellowish or hair-brown, which, by heating, may be made to assume a yellow or red color. This ore has the same composition, if pure, from whatever place it may come. Impurity, however, is always present, which reduces the yield of metal below the theoretical amount. It is easy of reduction and this fact probably, when combined with the great weight of the ore and the brilliant whiteness of the smelted metal, will account for its early discovery.

Cassiterite is almost always found associated with primitive rocks, chiefly granite. It never occurs as does iron, in seams, or in narrow solid veins, as do galena and some other ores, but disseminated in detached and often very minute crystals in the vein-stone. The veins may vary from a few inches to many feet in width, and through this mass the ore is dispersed with great irregularity, large

* The name cassiterite is derived from the Greek word for tin (kassiteros) and this in turn probably is a derivative of the Sanscrit "kastira" and would alone indicate an eastern origin for the metal. Hence the name of Cassiterides would naturally be applied to Cornwall and the Scilly islands. There is a Cassiter Street in Bodmin, the county seat of Cornwall, to this day. Hannibal is a frequent Christian name in Cornwall and the practice of kindling fires on the hill-tops on midsummer eve was in vogue within a few years and may be so still—a relic of the worship of Baal, the great god of Tyre.

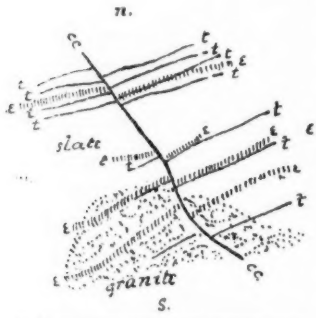
parts being absolutely barren, while through others the cassiterite is diffused in shreds, streaks and patches. This scanty diffusion in the granite or other matrix and the small extent of workable tin country yet known in the world are together the causes of the scarcity and high price of the metal in the market. The only countries in which we have any real knowledge of the geology of cassiterite are Spain, Saxony, Britain and to a smaller degree South Dakota. In all the other regions from which tin is obtained the ore is for the most part picked up on the surface and not mined below it.

In Cornwall the granite occurs as a number of bosses projecting through the slates which formerly overlay them, but have been removed by erosion. Dartmoor in Devon is the largest of these, and

they continue in a southwesterly direction through Cornwall and the Scilly Isles, but not all of them are equally stanniferous. The cassiterite in Cornwall occurs in lodes that traverse alike the granite and the slates and are consequently of later date than both. These lodes run in a direction from West-northwest to East-southeast, and are cut by a series of cross courses running nearly north and south and often carrying lead, silver or manganese but rarely tin. The country is thus cut up into a number of rudely rectangular blocks and the points of greatest productiveness—or pockets—are at the intersections of the lodes with the cross-courses.

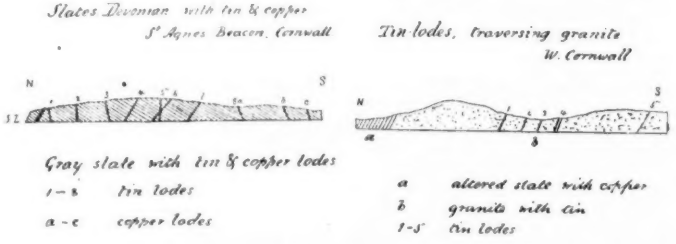
The geological history of the region is soon told in outline. The tin-veins are not ancient in a geological sense. The slates and

culm (anthracite) of Devon and Cornwall are of Devonian and Carboniferous age. The elevation of these by the rising granite took place probably about the end of the Carboniferous era, and was therefore contemporaneous with the Appalachian uplift in North America. From that time erosion has been removing the slates and exposing the granite Following this elevation at an unknown interval came the movement which produced the set of east and west cracks, in which the cassiterite with its accompanying minerals was afterwards deposited. These cracks pass through the granite and the slate indiscriminately, as shown in the accompanying plan, proving that they are of a date later than that of the elevation. After all this came the heaves which produced the north and south cracks or cross-courses which have been since filled with other ores and minerals.



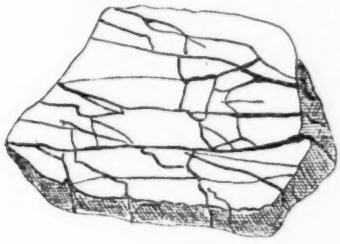
PLAN OF LODES AND CROSS-COURSES WITH ELVAN DYKES, REDRUTH, CORNWALL.
t tin lodes
e elvan [trap] course
cc cross-course, cutting and displacing lodes

The plan gives the evidence of these statements, inasmuch as it shows that the cross-courses cut and displace all the others, and in fact move the whole country so that the ends of the tin-lodes fail to meet. Evidently, therefore, the Cornish tin-stone is not geolo-



gically ancient. Whether it was formed by segregation from the adjacent rocks or sublimed from below or deposited from sea-water our space does not allow us to inquire. That tin ore has, however, been formed in other cases at a later date than that above assigned to the lodes is proved by the discovery of deer-horns so thoroughly

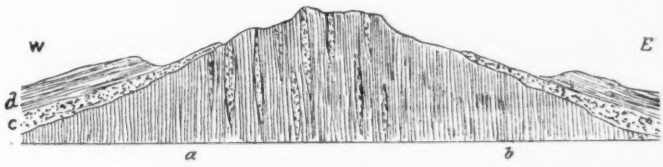
impregnated with cassiterite that they were as rich in tin as the average ore of the county. The lodes of tin ore not unfrequently split up into fine thread-like veins which so penetrate the slate that both must be worked together. An illustration of this structure may be shown in the accompanying figure.



Tin veins in slate. Cornwall.

The story of the Dakota tin is very different. There the cassiterite is confined strictly to the granite. But the granite is not a vast erupted mass as is that of Cornwall. Much discussion has been carried on regarding its nature, but judging from the evidence attainable it is a result of aqueo-thermal action. It occurs, so far as has been determined, in huge lenticular sheets interbedded in the schists and always or nearly always agreeing with them in dip. The schists containing the tin veins have been lifted more than once, but the granite veins were raised with them and must consequently antedate the uplift. Now as the Potsdam sandstone of the

Diagrammatic Section from E. to W. across the Black Hills of S. Dakota.



a Schists with lenticular stanniferous granite.
b Slates without granite.
c Upper Cambrian. (Potsdam) Sandstone
d Carboniferous Limestone

Upper Cambrian contains abundant fragments of these schists we are quite certain that they are at least of early Cambrian and probably of pre-Cambrian date. They must therefore be far older than the Cornish tin-lodes already described, having been already laid

down and lifted before the Devonian and Carboniferous beds of Cornwall had been deposited. Yet there is a wonderful similarity between the ores of the two places, indicating similar condition of formation. There are the same accompanying minerals, the proportion of tin-ore is in both equally low, and both are usually in close proximity to granite.

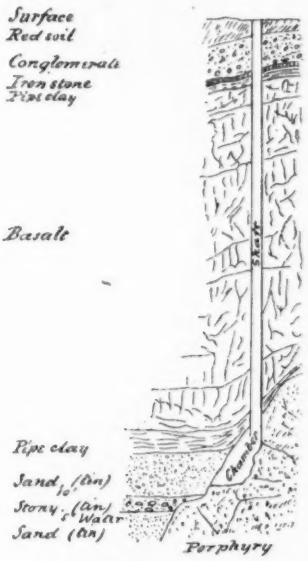
The tin-bearing lodes are for the most part on the western side of the Black Hills, among the older schists, and are of very different degrees of value. Some of them are of enormous thickness, exceeding 100 feet, but the cassiterite is not equally distributed in them. It is found in strings and patches and sheets and many of the veins and large parts of others contain none. They dip into the ground at high angles—usually about 70°—in this respect resembling the lodes of Cornwall, and their working will consequently be very similar. Immense quantities of cassiterite exist in the hills. The granite veins are very numerous and a large proportion of them are more or less stanniferous. But the percentage, as elsewhere, is very low, about equalling the average yield of the Cornish mines at present in operation. It is not easy to give figures but a sanguine estimate might put both at 2 per cent. and probably in order to attain this some of the poorer mineral must be excluded.

The tin works of the Erzgeberge mountains, between Saxony and Bohemia, are of little importance, but deserve notice because the cassiterite does not occur in distinct lodes but forms a network of small veins traversing the stanniferous rock. A mine in rock of this kind is called a "stockwork." The appearance of such cassiterite as this may be seen in the figure shown for Cornwall. Cassiterite so diffused is more costly to work than the kinds already mentioned and were it not that the mines have been operated for many years and that labor is very cheap and appliances simple, the Saxon and Bohemian tin mines could not remain open. In the stockworks of Altenberg the rock is said to contain .33 to .50 per cent. of cassiterite. Their yield is constantly decreasing and from some has already ceased. The nearly extinct tin works of Spain need no more than mention here. In 1881 they produced 12 hundredweight of cassiterite. Nor is there any occasion to dwell on the small and little-known deposits of Bolivia and Peru.

The granite of the Temescal range, in San Bernardino County, California, has yielded small quantities of tin ore and a few rich specimens. In 1861 considerable exploration was made in the region and this has recently been renewed. But so far as is known

the conditions of the occurrence of the mineral do not differ from those obtaining elsewhere. Maine, Alabama, Massachusetts, Virginia and South Carolina have at various times yielded a show of cassiterite and always in close connection with primitive rocks.

But all other deposits of tin fade into insignificance compared with those of the southeastern regions of the Eastern hemisphere. The wealth of Malacca—the Golden Chersonese of the ancients—has been known for centuries but only of late years have its enormous stores of tin been brought into the market. The long granitic axis of the Malayan peninsula and its continuation in the island of Banca is traversed by quartz veins containing tin-stone often so pure that it is of a light brown color or even translucent. From these veins large quantities of cassiterite have been washed down into the valleys where it is now gathered. The lodes resemble those of Cornwall but, if we may judge from appearances, must be vastly richer. No attempts have yet been made to work them. All the tin-stone exported is picked up or washed out in the water-courses, as was formerly done in Cornwall. This is the "stream-tin" of the miner and its collection is called "streaming." It is in Malacca remarkably free from arsenic, sulphur and wolfram, but whether or not this same high quality will be maintained in the lodes remains to be seen.



Tin shaft at Vegetable Creek in N. South Wales.

Equal in richness and in value to these are the recently revealed tin deposits of Queensland and New South Wales. The granitic range of the eastern coast of Australia is the matrix from which the tin-stone has been derived and all that has yet been done is to mine and wash the stream-tin that ages of erosion have accumulated on the surface and in the water-courses. The workings on Vegetable

Creek, in New South Wales, have proved wonderfully productive. The accompanying section will show their geology. Ninety feet of basalt cover the sands and gravels of an ancient buried river-bed in which the tin ore was found. Below this and under a bed of pipe-clay occur the stanniferous sands and gravels fifteen feet thick above water-level. How far they reach below is not known, as the workings at present cease when the water is reached.

Later still the developments in Rose valley have even surpassed these. From this mine, which closely resembles the other and lies near it, more ore was taken in 1881 than is produced by any of the Cornish mines, with the exception of some half dozen. These Australian tin-lodes reappear in Tasmania on a somewhat smaller scale and considerable ore is now coming from Hobart, more than 3000 tons having been shipped in 1881.

This table includes all the regions that now contribute any appreciable amount to the world's stock of tin or in which the ore possesses any geological interest.

Cornwall (1882)	9000 tons of metal.
Saxony (1880)	170 tons of metal.
Italy (1880)	16 tons of metal.
Russia (1879)	2 tons of metal.
Japan (1875)	7 tons of metal.
Penang and Signapore (1882)	15,942 tons of metal.
Penang and Signapore (1887)	18,515 tons of metal.
Penang and Singapore (1888)	25,594 tons of metal.
Banca and Billiton (1882)	8550 tons of metal.
Victoria (1880)	103 tons of metal.
New South Wales (1882)	6500 tons of metal.
Queensland (1881)	63,000 tons of metal.
Queensland (1882)	16,380 tons of metal.
Tasmania (1881)	3500 tons of cassiterite.

Though the old mines of Cornwall, Saxony and other places will continue to yield a probably diminishing quantity for many years, and though the known deposits in North America may in future be utilized, yet it is to the southeast that the world must look for the present supply of its ever-increasing demand for tin. It is not likely that the rapid increase in output will be maintained. The stream-tin will become more difficult to work as the accessible parts are exhausted. But the steady following downward of lodes that contain cassiterite can scarcely fail to yield returns that must enable these countries to control the price of tin for many years, and probably reduce it.

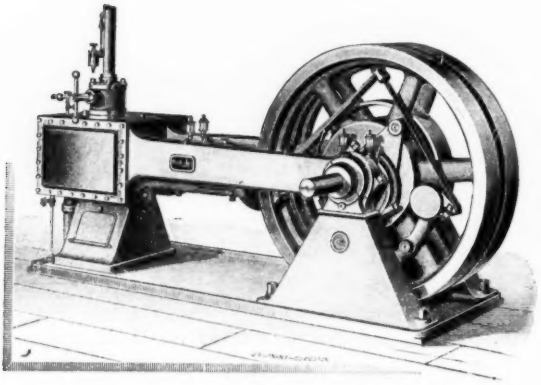
AMERICAN SUPREMACY IN APPLIED MECHANICS.—II.

By Coleman Sellers, E. D.

AN American machine-tool builder visiting an English workshop was shown, as a copy of an American planer, one adapted to planing the stub ends of connecting-rods for locomotives, there being two sets of uprights and two crossheads and four tool-holders adjustable in position for enabling both ends of two connecting-rods to be planed simultaneously. The American tool from which the idea was taken has its crossheads facing one another and the lathe is speeded to run back and forth at the same rate of cut. By this means the machine is made to take a cut at each forward and backward movement of the table. The English machine had its tool-holders facing all one way and all four cuts were taken at one and the same time only when the table was running forward, no work being done at the back stroke. The power of the American machine was therefore double that of its English copy, all other things being equal, and the designer of the copy was astonished when this was pointed out to him.

This one example shows how difficult it is to copy the machinery of another country if the copyist does not grasp the controlling idea of the mind that gave life to the original. This is shown in many other directions where American contrivances, having obtained a world-wide reputation and being copied away from home, are very apt to be less efficient in the foreign production than in the original.

As an instance of freedom from all precedent as a guide, Professor Sweet's straight-line principle of steam-engine building is a notable instance of well-thought-out and correctly-applied principles in applied mechanics without precedent. In this case the lines of strain in the engine are traced out and the material is placed in the position best adapted for receiving these strains, all of which has resulted in increased durability, making the parts more accessible, and instead of adding weight materially diminishing the total weight of the engine, but resulting in a construction quite regardless of custom.



PROFESSOR SWEET'S STRAIGHT-LINE ENGINE.

The practice adopted in many American shops of keeping an exact record of the inspection of all machinery with the record of every accident that occurs in use with the failure of any one part, with a view to correcting these faults and with the introduction of means for testing the accuracy and correctness of the structure, has helped to raise the standard of mechanical superiority.

The development of the theory of broad-finishing cut, so little appreciated abroad, has in America led to some of the most remarkable improvements in methods. The very excellent car-wheel boring machines made in America and required by the car-wheel makers—an industry having no exact equivalent abroad where cast-iron wheels with chilled threads are not used—are now made with conveniences for quickly changing the rate of feed, for quickly changing the cutting tools, with admirable devices for "chucking" the wheels, and conveniences for handling them. It is by and through these improvements that one workman is now able to turn out ready for the wheel-press more than a hundred wheels a day from each machine.

The most striking instance of what has been brought about solely by the appreciation of this method of working metal is seen in locomotive shops, where new machinery has now been put to work that has reduced the time of boring a 19-inch locomotive cylinder to three hours and a half, when in 1850 nine or ten hours was deemed a great improvement on the early practice of twenty hours' time spent on each cylinder. This rapidity of production, now so common, is accompanied with better workmanship than ob-

tained in the earlier practice. This principle being recognized, machine-tools of all kinds were so arranged as to render the principle applicable to practice and convenient in changing from one rate of feed to another. The American tool-builder keeps in view convenience and handiness, knowing that much of each workman's time is lost in adjusting feeds, setting work, and in getting ready for actual cutting.

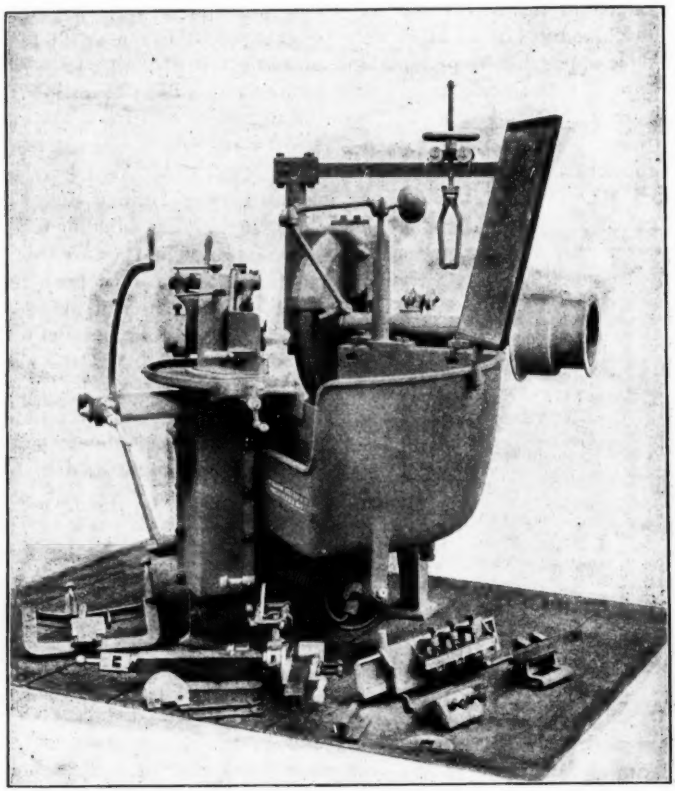
Mr. Holtzapffel, in his valuable work on "Turning and Mechanical Manipulation," published in 1846 and 1847, alluding to the work done by machine-tools and commenting upon the care that is required to form the cutting-edges of the fixed tools, the little power of deviation either at right angles to or parallel with the surface to be wrought, and the want of the tools to admit of some accommodation of position to compensate for erroneous construction or subsequent deterioration from wear as when they are held in the hand of the workman and directed by his judgment, then adds: "It must also be additionally borne in mind that however ponderous, elaborate or costly the *machine* may be, its effectiveness *entirely depends* upon the proper adaptation and endurance of the *cutting-tool* through the agency of which it produces its result."

HENRY BURDEN.*

The improvements made in modern machine-tools, carrying them nearer and nearer towards perfection so far as accuracy of movement is concerned, strength of parts, rigidity under severe strains, adaptation of the feed to the work that is to be accomplished, possible quick adjustment of all parts, after a time reaches a limit, and that limit can only be further extended by improvements in the fixed tools that really do the work, as this celebrated writer has said.

In 1884 a visit to the Whitworth establishment in Manchester, which for years stood at the head of tool-building in England, found but little change in the form of design of his best machinery, but an increased strength of parts and the substitution of steel of the best quality for cast-iron in gearing, always looking to a

* Henry Burden, of Troy, N. Y., was the first to make horseshoes by machinery, and was long the only maker. He made valuable inventions of machinery for making horseshoes. Machinery for this purpose is little used in Europe, while here it is used universally.



AMERICAN TOOL-GRINDING MACHINE.
[For doing all work required after forging to finish tools to shape.]

strength exceeding what would be required by the improvements made in the fixed tools that were controlled by the machines.

At this time Sir Joseph Whitworth was chiefly interested in producing his compressed steel and had made his hydraulic forging machine for shaping ingots in place of heavy hammers. Economy of output called for the most improved methods of doing the tooling that is necessary either in advance of or after the hydraulic forging had put the ingot into the shape required.

In the United States, with the same exciting causes, the improve-

ments in these cutting-tools necessitated improvements in the grinding-machines for shaping the tools, but at last a point was reached where it became necessary to find some mode of treating hardened steel that would enable the shapes of the cutting edges that had proved the most advantageous to be produced automatically. This led to a series of inventions that extended over a period of ten or fifteen years, during which time many independent inventors worked on devices for sharpening the cutting lips of the drills. These were followed by machinery capable of forming models which in turn could be used to reproduce automatically in hardened steel cutting-tools the shapes that were required and had been found able to produce the best result. This marked an era in processes that are as yet only in infancy. With the automatic tool-grinding machinery of America it is possible to give to every workman in the shop cutting-tools best adapted to the work that is to be done, cutting-tools far exceeding in the amount of metal they can remove the work of the most skillful tool-grinder, who has only his eye and judgment to guide him.

JOHN A. ROEBLING.*

To introduce this class of machinery in the older countries the manufacturer comes directly in contact with the trade customs and trade rules. Good workmen think that their skill depends upon their knowledge of how to sharpen the tools that they require to do their work and resent any interference with their methods. It is possible, however, when a system is introduced whereby men are paid not by the day but by the amount and excellence of the work they produce, that they will accept with readiness what will enable them to do more work in a better manner and relieve them of the trouble and time spent at the grindstone.

We have in America many skilled machinists who fully appreciate all the efforts that are made by the employers towards perfecting labor-saving devices. It is possible, also, in the case of machinery that is entirely automatic, to have one man run several machines, a course of proceeding that is forbidden in some coun-

* John Augustus Roebling, born in Prussia, 1806, died 1869. After graduating in Berlin as civil engineer, he came to America and began a settlement near Pittsburgh, Pa. In 1813 he established a steel and iron wire rope manufactory, first using the wire to suspend a wooden aqueduct over the Allegheny at Pittsburgh. The suspension bridges over Niagara, over the Ohio and over the East River are the fruits of that successful experiment.

AMERICAN FIRE-ENGINE IN 1818.

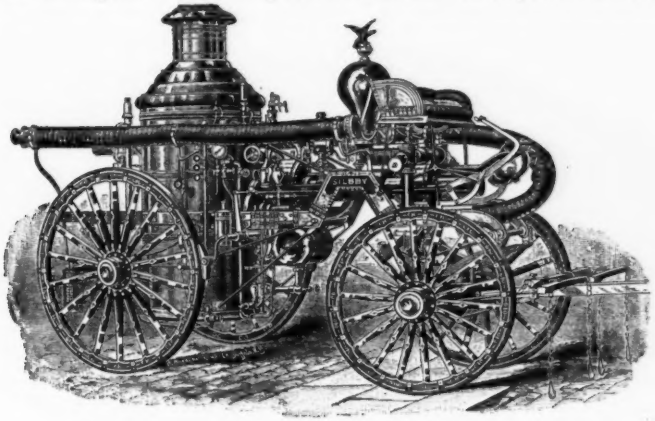
tries by the trade rules that hamper the workmen, but in carrying out these methods there must be a feeling of confidence between the employer and the employé.

It is so manifestly to the advantage of the employer to have the amount of work done by any one costly tool increased, that he should for his own sake encourage this increased production by the amount of wages it is possible for a man to make over that which has been customary from experience gained during the rapid execution of similar kinds of work, always recognizing advantages to be gained by high wages that yield a larger output and consequent diminished cost of production.

The reports of our Centennial Exhibition give us an insight into the impression made by our display of progress in 1876. The International Jury of 1876 was arranged so as to assign foreign and native judges to each group or sub-division of objects exhibited. Each group of judges in organizing elected its own chairman and secretary. Having examined the most important exhibits in company, they delegated one of their number to write the recommendation for award in each case, after which the recommendations were considered at the meeting of the group and if approved were countersigned by all the members of that group. This was designed to insure uniformity in manner pursued and as far as

possible to grade the expressions of commendation in award. The judges appointed for the examination of Group 21, who had to consider steam-hammers and machine-tools, were a very able body, in both its foreign and its American membership. Mr. John Anderson, of the Woolwich Arsenal, Great Britain, was the chairman. He had been a judge at all the preceding world's fairs, and had made a study in connection with his profession of the objects he had to pass upon. In regard to machine-tools for working metal, he said in one of his reports that "this exhibit when considered in regard to its extent and value, its extraordinary variety and general excellence, as also for the large amount of originality that is shown in the numerous new devices that are introduced, is probably without a parallel in the past history of International exhibitions, and, taken as a whole, it is worthy of the highest honor that can be conferred. Besides, it is thoroughly national in its characteristics, and pre-eminently of the United States and the grand occasion of the Centennial Exhibition."

He spoke of the high class of the workmanship, of the beautiful outlines that are imparted to each structure, of the correct proportions that have been worked out in determining strength and form, and the disposal of material to take full share of duty: "For the scientific skill displayed in the application of mechanical force, for the daring shown in fearlessly breaking through the trammels of the past, by introducing variously-constructed devices and arrangement of gearing for the transmission of power in more



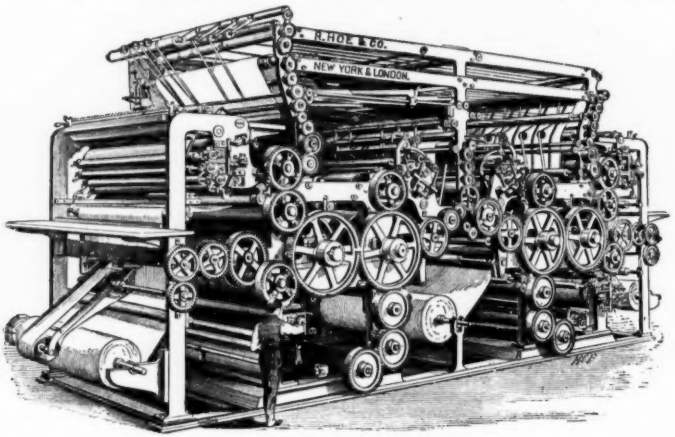
STEAM FIRE-ENGINE OF TO-DAY.

direct course to the point of action, yet maintaining correct construction mechanically, and without departure from true principles."

In Dr. Anderson's final report, when the British Executive Commissioner and staff returned from the Centennial Exhibition, and their respective reports were presented by command of the Queen to the Houses of Parliament, he says:

PRINTING-PRESS OF FRANKLIN'S TIME.

"The display of machine tools made by the United States was so vast that only the more salient points can be noticed in a brief report. It showed certainly that the past century had not been passed in idleness, and, judging by the enormous stride made by them during the past few years, it showed that they have been intelligent students of the best European authorities. It is true to say, however, that the Americans, as a rule, are not copyists; the inventing of clever devices and tools for saving labor seems to be their *forte*, and worthy of the old stock, probably



NEW YORK "HERALD'S" SEXTUPLE PRESS.

[Weight, fifty-eight tons. Capacity 72,000 eight-page papers, folded and pasted per hour.]

quickened by the peculiarly favorable circumstances under which they live.

"It was the display made in this section which most conspicuously brought out the enormous strength of America as a producing power. More than a hundred exhibitors each had a large exhibit that commanded the admiration of all who took the trouble to examine them in detail. In this vast array were machines for all purposes, small arms, ammunition, sewing-machines, clocks, watches, and all the branches of machine making and engineering, and almost all were finished in a style superior to that of any former Exhibition."

RICHARD M. HOE.*
[From Harpers' Weekly; with permission Harper & Bros.]

"Great Britain," he says, "certainly can claim the credit of having been the birth-place of modern machine tools, and has done wonders in raising the mechanical standard of perfection, and her influence for good in the advance of civilization thereby is incalculable. But when we consider the enormously greater area of the American continent it is a matter of vast importance that tools have taken such a hold of the American mind, which will influence the civilization of the Western world for ages to come, and will exercise a powerful effect, not only on that continent, but on Australia, China, and the world generally; this, therefore, has a profound significance which can scarcely be overrated."

The improvements in machine-tools are not made so much at the instance of those who use them generally as by and through the exertions of those who made them, excited by their own long experience with this class of machinery. Thus, machine-tool building stands alone as an industry in which the makers of the machinery use and sell their own product. They themselves require the lathes, planers, boring and drilling machines that are needed in the manufacture of all other classes of machinery, so that the machine tool-maker has the two exciting stimulants, viz.:

* Richard March Hoe, born in New York, 1812, died 1866. His father, the first American machinist to use steam, was partner of Matthew Smith, inventor of a hand printing-press which Hoe improved. Richard entered the business, and invention followed invention, until he made rotary presses into which were fed ribbons of paper five miles long, 800 feet a minute, which other mechanisms cut and folded. William Bullock invented the use of the ribbon.

That in the first place, which will serve his own purpose best, and this leads to what will serve others as well.

In America the machine-tool builder meets with no restrictive trade rules. There are no Board of Trade or Parliamentary regulations to hamper his work or his progress through inadvised laws for the protection of the lives and persons of the workmen. He has before him the unwritten laws that serve the purpose so well, as it is to his advantage to avoid any possible suits for damage brought by workmen who sustain personal injury.

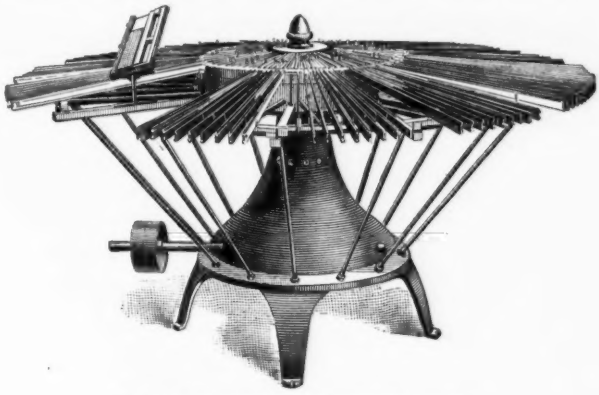
MCMILLAN TYPE-SETTING MACHINE.

Watchmaking in the United States has been reduced to a perfect wholesale-manufacturing system and the tools required in this new industry are of the highest order of excellence. To a mechanic capable of judging of good workmanship and having a fondness for good tools to work with, the product of the machine shops that equip the several watchmaking factories in the country fill him with pleasurable excitement. The mere possession of a lathe such as is used by the makers of the Waltham watches, not for the purpose of doing the watchmaking but for the production of the intricate tools required to make the parts of a watch—a lathe perfect in its most minute particular and equipped with intricate "chucks" and ingenious tool-carriers—has been the desire of many a mechanic who has spent hours in examining the exhibits of such machinery at the several world's fairs.

A visit to any one of the leading watchmaking establishments is of interest to all observing people. They will find buildings

erected of immense size, thoroughly well-lighted, carefully ventilated, warmed or cooled with perfect conveniences for the operatives so far as their personal comfort is concerned, and a class of operatives far beyond what are brought together in almost any other country.

In these establishments women who know nothing of watch-making in its entirety are trained each to make some special part of the delicate mechanism of time-pieces. Where minute holes are to be drilled, accurate machines guide the location and direction of the drilling-tools, but the women employed at each machine are not even required to sharpen the drills themselves. Another operative, with the proper appliances, is continually employed in sharpening these various cutting instruments, each one doing its work automatically by means of machines which regulate the grinding



MCMILLAN AUTOMATIC TYPE-DISTRIBUTING MACHINE.

devices, so that the American watch when completed shows no pure human mechanical skill, but it is the outcome of a talent that has created machinery capable of doing each and every part of the work far more perfectly than the same amount of work could possibly be done by skilled workmen using hand tools only.

Between such establishments as these and the lace manufactories of Nottingham what a contrast exists, and what a contrast there is between the operatives of the two establishments. The one surrounded with all the comforts that a human being can wish, with gardens spread before them outside of their open windows, with absolute cleanliness and perfect hygienic surroundings, the bright

sunshine comes to them, and their faces show health and intelligence. The visitor to the lace factories of Nottingham may be indeed interested in watching the complicated machines forming the threads into such intricate and beautiful patterns, but everywhere there seems squalor and misery, not cleanliness but dirt, while in some rooms the casual visitor is warned not to enter—the air is so foul, so sickening, that the lives of the operatives are shortened to a degree that makes one wonder how human beings can be induced to accept such a life with its attendant miseries.

Dr. Anderson in commenting upon American methods said in his report to Parliament that in the cases where the judges threw upon the makers of the machinery exhibited at the Centennial the odium of proving their claims to superiority, the American manufacturers alone came forward at once with instruments of precision to demonstrate their claims for perfection of workmanship, and the gauges and devices that were used for this purpose were only those that were employed every day in the shop to satisfy themselves in regard to their own work and to secure uniformity of output.

RICHARD J. GATLING.*

With the American the question as to any new mechanical effort is not "Can men be found to do the work properly?" but "Can machinery be found or invented that will accomplish this end?"

Builders of locomotives in America can find sale for certain standard types and standard sizes of locomotives and are thus able to manufacture engines at wholesale. There are many railroads in America willing to take from the builders what has been shown to be good and effective machines. When the same kind of machine is repeated many times the maker can afford to invest heavily in special gauges and special tools that will do away with manual skill in laying out the work and working to drawings. The first time any piece of work is done more time is spent on it than after the workmen have become used to it, and certainly more time than

* Richard Jordan Gatling, born in North Carolina in 1818. He helped his father, a manufacturer, to perfect machines for sowing and thinning cotton, and when a boy invented a screw for propelling water-craft, a rice and wheat sower, a steam plow, and a machine for breaking hemp. In 1861 he invented the revolving battery gun that bears his name, firing 1200 guns per minute. The United States and foreign governments use it.

would be spent after special appliances had been brought to bear to cheapen the product, but especially when the men are to be paid for their work according to the quantity and quality made and not by the time spent in doing it.

It is no unusual thing to find in the hands of the British locomotive-builder a specification from some foreign railroad, let us say some French railroad, for an engine that has been designed by the officers connected with the railroad. These men, sometimes young men of decided ability, are anxious to make for themselves a name and to introduce novelties, and are not familiar with shop customs. Such specifications bind the manufacturer to the most minute exactness as to shape, size, and construction of every minute detail of the engine. There is no attempt made to take from the market existing goods, but each must have the stamp of the individuality of the designer of the machine. All this costs money, and costs a great deal of it too, and does not advance the art of locomotive-building as much as is the case when men having given their whole attention to the one subject have worked up their special styles of engines to the greatest perfection both in utility and accessibility.

JOHN A. DAHLGREN.*

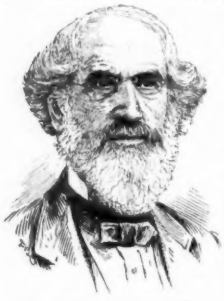
It is the builder of the machine who has to do with the possible repairs in the future, who through long experience and practice can design what will be the most acceptable to the men who are to operate it, and the most convenient when accidents occur and repairs must be made quickly.

The American locomotive-builder has continually in view efficiency, durability and ease of repair and adjustment. The parts must be accessible and, as far as possible, interchangeable. This principle is to be seen in one of the American systems of compound locomotives, enabling existing non-compound engines to be readily converted into compound.

In the long controversy about the merits of the American and

* John Adolph Dahlgren, born in Philadelphia, 1809, died 1870. He entered the navy, and for his proficiency in mathematics was detailed to survey-service. In 1847, when a lieutenant, he was assigned to ordnance duty in Washington, where his skill and energy revolutionized the naval armament. In 1850 he invented the gun that bears his name. In 1863 he was made Rear-Admiral, and awarded the thanks of Congress. He published books on ordnance.

English style of locomotive, the trial now being made by the Pennsylvania Railroad of the English compound engine running between New York and Philadelphia, is not likely result in radical change in the American system even if that particular compounding system should be adopted. It must be modified to meet the conditions obtaining here and not possible in England. It is being tried in competition with American types of engines having as great an efficiency and in keeping with American requirements. In treating this subject it is difficult to avoid personality and avoid the prejudice of custom, yet American engineers are perhaps more free from this prejudice than others as they are so constantly seeking for the best results with more freedom of thought.



THADDEUS FAIRBANKS.*

A very celebrated builder of locomotives in England said that the rules of the Board of Trade and Parliamentary regulations for the safety of the people crowded their locomotives with much useless detail. A close observer of railroad machinery, familiar with all railroads of the world, speaking of the purpose of these papers, says that give a locomotive-builder abroad a new problem such as a hill-climbing freight engine, or a "goods" engine, as it is called abroad, or even an express passenger engine for mountain districts, and a completed machine is the result that is built for strength and durability but is inaccessible in the extreme. It is easier to take out the cylinders and replace them with new ones in an American engine than it is to reset the valves on the kind used abroad where the valve chests are crowded together under the smoke-stack as if they would never require adjustment. The cranked axle is adhered to in spite of its weakness. Give accessibility to the valves and ready access to all parts and the whole engine will be better cared for by those in charge of it. The standard locomotive of England on the good roads is certainly an efficient machine, and with shops equipped to repeat that type, with natural prejudice in its favor it would be useless to think of a change to the American style, which is also in a measure in like manner fixed by the equipment of the American workshops.

* Thaddeus Fairbanks, born in Massachusetts, 1797, died 1886. As a boy he showed fondness for mechanics, which was developed in the varied industries of his father, who manufactured carriages and had a saw and grist mill. In 1822, while a member of a firm for dressing hemp, the son saw how defective were the scales, and began the invention that has produced the scales that have taken numberless medals and are used the world over.

The difference between English and American locomotives, the subject of so much comment and argument, is perhaps not clearly understood by many who think only of the efficiency of one or the other style of engine. The claims made for the American type of engine based upon strength and elasticity of the machine due to the American equalizing system, adapted to do good service on an imperfect roadbed, is in the opinion of many no longer tenable in the case of roadbeds in America that are quite up to the highest standard of solidity and perfection of alignment of rails. To the non-technical reader it may be interesting to know that rails were laid for hauling from mines many years before steam was used in the place of horse power.

S. F. B. MORSE.
[Inventor of the Telegraph.]

When Oliver Evans in 1804 drove his "Oructor Amphibolis" through the streets of Philadelphia by steam-power and having launched it into the river steamed down the Schuylkill and up the Delaware against the head wind, he predicted that the time would come when people would travel in stages moved by steam engines from city to city almost as fast as a bird flies—fifteen or twenty miles an hour. Passing through the air with such velocity, changing the scene in such rapid succession, would be the most exhilarating exercise. "A steam carriage will set out from Washington in the morning, the passengers will breakfast in Baltimore, dine in Philadelphia, and sup in New York the same day." "To accomplish this, two sets of railways will be required, laid so nearly level as not to deviate more than two degrees from a horizontal line, (two degrees equals about 170 feet to the mile, C. S.)—made of wood or iron, or smooth paths of broken stone or gravel, with a rail to guide the carriages, that may pass each other in different directions, and travel by night as well as day." Oliver Evans died in 1819, having never seen what we are familiar with now as locomotives.

ELISHA GRAY.
[Electrical Inventor.]

Locomotive-building in America has been from the first carried on separate and distinct from the railroads requiring them. Many

railroad charters do not permit locomotive-building. The early attempts of Col. Stephen H. Long who, in 1830 obtained a charter from the State of Pennsylvania incorporating the American Steam Carriage Company, to run his engine on July 4, 1831, over two miles of rails that were being laid on the Newcastle and Frenchtown Railroad, were unsuccessful. This locomotive weighed only about three and a half tons.

It was soon after this that Matthew Baldwin began to build locomotives in shops that now turn out more than 1100 locomotives each year. From that time up to the present moment, establishments for building locomotives have sprung up in various parts of the United States, with a certain amount of uniformity in the principle of construction of the engine that has been adhered to on account of the fitness of the essential features for their intended purpose.

[*TO BE CONTINUED.*]

ART AND ENGINEERING AT TUXEDO PARK.

By James Smith Haring, M. Am. Soc. C. E.

TO the eye practised in observing the changes wrought by the skill of the engineer in transforming the appearance of unimproved nature, Tuxedo Park* affords a study of deep interest. Through this wild and rugged waste of mountains, with scenery picturesque and grand in the extreme, Erskine constructed his military road for the passage of Washington's army from Valley Forge to White Plains, this road being probably the first engineering work done in this section. The "Old Continental Road" still exists, forming part of one of the many fine drives in the Park. Some admire it as the most attractive drive in one particular—its arch of overhanging and interlacing thick-foliaged trees. Before the plans for the development of Tuxedo Park were made public, this Continental road, then a public highway and the only one running east and west through the Augusta tract—as the property was then called—was taken up by the Commissioners of Highways of the town of Tuxedo, upon an application in behalf of the Tuxedo Park Association, and its use was discontinued. There was a public protest against this action, but there is no question of its importance or necessity, for with a public highway through the very heart of this tract the privacy which has been the secret of success of Tuxedo Park could not have been secured.

When this estate, comprising 13,000 acres, came into the possession of the Lorillard family, in 1814, the land was valuable only for the timber, most of it being unimproved mountain land. Some iron ore was mined from the deposits still only partially developed, and a small quantity of silver, besides which a lime-kiln was once operated on the premises. But the only paying income from the property was from the sale of cord-wood to the Erie railway before coal came into use as fuel. When the wood business became unprofitable the idea of some other use of the land, then reduced in area to some 5000 acres, was conceived by the elder Lorillard, who caused some surveys to be made for both park and mining development. It remained, however, for the present President of the

* Tuxedo Park is located in Orange County, N. Y., in the town of Tuxedo, and not in New Jersey, as so many believe, though the town adjoins the New Jersey State line on the southwest.

MAIN ENTRANCE, LOOKING WEST, FROM ORANGE TURNPIKE.

Tuxedo Park Association to plan and push to successful accomplishment the enterprise which stands to-day as one of the greatest features of its kind, carried out unaided by one man.

To any person who has carefully studied the features of the Tuxedo enterprise, from knowledge and a standpoint obtainable only within the confines of the Park, and intercourse with the founder and its inhabitants, it seems plain that the social conditions imposed, restrictive though they may seem, are essential to present and continued success. Considering how much money has been spent and how much more must be spent to sustain the enterprise, it will be seen that the financial ability of the patrons must be of the very best. The problem for the engineer is to make this a place of healthful residence as well as to contribute by his art to the pleasure and recreation of the residents.

Upon his first visit to this tract, in October, 1885, the writer saw, unimproved except by a few straggling wood-roads, a wild waste of mountain land, wooded by timber of stunted growth, as far as the eye could reach. Tuxedo Lake* was reached by an effort and it could be viewed only from points by no means easy of access. Three years later, when again visiting the place as engineer in charge, it was impossible to locate the points which marked the former wood-road, so greatly had the aspect of the place been changed by those engaged in its improvement.

As is so often the case, the mistake of placing the engineering corps and the laborer side by side in a work of this magnitude, was made here. The writer saw the first transit line being run for the main road leading from the railroad station to the Club-House; simultaneously came the location of the Club-House and the Entrance Lodge; tools, men and materials came in grand confusion; the exceptionally quiet and orderly region was thrown into a state of feverish excitement; employment was to be had for men of any trade or vocation; teams, mechanics, laborers of all kinds were engaged without question and at rates of compensation which de-

*Mr. William Waldorf Astor, in a report to the Tuxedo Club, mentions early records containing these spellings: Tuxedo (first in 1754) Tuxcito, Tuxetough, Tucksito, Tugseto, Tucsedo, Texedo, Toxedo, Duck Sider, Duck Cedar. It is suggested, with regard to the meaning of the word, that a habit of the Algonquin Indians was to name a place after the chief whose tribe occupied it, and this clew being taken up, mention was discovered of a sachem named P'tauk-Seet, "the bear," who, in the seventeenth century ruled over a tract of country including Tuxedo. Uniting his name with *tough*, the Algonquin for *place*, the original spelling may have been P'tauk-Sect-tough, and its meaning "The Home of the Bear." Another surmise is that, as the forest called "The Greenwood," and lying westward of Tuxedo, was occasionally the refuge of bears, the district may have received from the Indians the appellation, "Place o Bears."

VIEW OF MAIN ENTRANCE TO TUXEDO PARK, FROM THE INSIDE.

moralized the ordinary work of adjoining towns; many too, were hired for skilled mechanics who probably had never even plied a tool before. The waste was therefore appalling, loss was not considered, the only object in view being the construction of buildings and roads, and this object was speedily attained. The development of the beauties of this park is due to the fact that one idea prevailed, and that money and skill and all other essentials were authorized without limit by the liberal hand of the one man to whom Tuxedo in its present condition is due. He was the provider not alone of capital, but also of the conception in its minute details. He was almost constantly supervising the work and planning its scope by personal presence and management, aided by his most efficient manager, Mr. T. Burnett Baldwin. The engineering work was under the direction and charge of Mr. Ernest W. Bowditch, the landscape architect of Boston, and a large corps of assistants; yet many of the charming features, so much admired, were conceived by its owner, Mr. Pierre Lorillard.

The striking entrance and broad macadamized drives, passing the peculiarly artistic entrance lodge and keep—the dream of Mr. Bruce Price who, as an architect, has done so much for Tuxedo, and who has in so many ways by his striking and quaint designs, stamped his individuality upon it—give one who passes on, without entering the gates, but a faint idea of the landscape which lies within. Entering upon a drive twenty-five feet in width the superior character of the roadway quite surprises and captivates the visitor. There are graceful curves and smooth, hard, well-graded surfaces, constructed of three sizes of stone (gneiss) crushed upon the premises. At the entrance one is also charmed by the expanse of lawn, well-kept, regular, its background of forest trees forming the landscape into a perfect picture. The massive rustic fence, covered now with a heavy foliage of creeping vines, adds finish to the roads and lawns and nature seems joined to art in perfect harmony.

A quarter of a mile inside the entrance is obtained the first real view of Tuxedo. At a breach in the trees the range of Tower Hill and the striking cottages of its summit over the Polo Grounds and speeding track of half a mile, burst upon the view. A pine swamp was here—a dark, wet, thickly-wooded morass, with muck twenty or more feet deep—and this change has been made by the expenditure of thousands of dollars. Upon leaving the Polo Grounds one sees the largest of the few lawns maintained by the

TOWER HILL, LOOKING WEST, TUXEDO PARK

Association, a triangle planted with shrubs with such good judgment that some of the many varieties are in flower nearly all the season; the evergreens and rhododendrons make a fine feature, the whole effect reflecting credit on the good taste of Mr. I. L. Powell, who was for some time the gardener of the Association.

Another swamp reclaimed is on the right, the property of Mr. James L. Breese, who has exhibited such fine taste in improving his various purchases of land; here a former swamp covered by forest trees is to-day a garden of large proportions, symmetrically laid out, and producing sufficiently large returns in vegetables to pay the expenses of gardening from surplus productions sold. Mr. Pierre Lorillard also has reclaimed a large tract of waste swamp-land, the expense of clearing and grubbing, draining and fertilizing costing him at least $300 per acre, but the production is gratifying. These spots may not "blossom like the rose," yet they attract much attention and admiration.

Near the lawn last mentioned is obtained the first view of Tuxedo Lake, with the gradually-unfolding beauty of the contours now fully open to view, and the effect is charming. Its length is a mile and three-quarters and its width half a mile. On one of the prominent points is seen the stately cottage of Mr. Pierre Lorillard; on the opposite shore "Turtle Point," the home of Mr. George Lorillard Ronalds, and just beyond, on opposite sides, the striking cottages of Mr. William Kent and Mr. T. Brownell Burnham, the latter "built upon a rock." All these having lawns of velvety appearance, the visitor is impressed with the idea that the rugged wildness of six years ago must have been a myth.

The water-mains are beneath these roads, in size from one to twelve inches, supplied from a reservoir of iron, stand-pipe form, containing 750,000 gallons of water. This is pumped from Tuxedo Lake, 330 feet below, by two Worthington pumping-engines of 1,500,000 gallons daily capacity. Fully twelve miles of mains are laid already, and more are soon to be laid. With this water supply is also a sewage system, planned after the best methods of engineering skill, and maintained with scrupulous exactness, for if there is any one thing more than another that the management prides itself upon, it is the care and attention given to its house-drainage system. No attempt is made to carry off surface-water; the peculiar character of the site requires but little attention to be paid to that, except to prevent washing out of roads and lawns, by a system of drain-pipes near the surface of the ground.

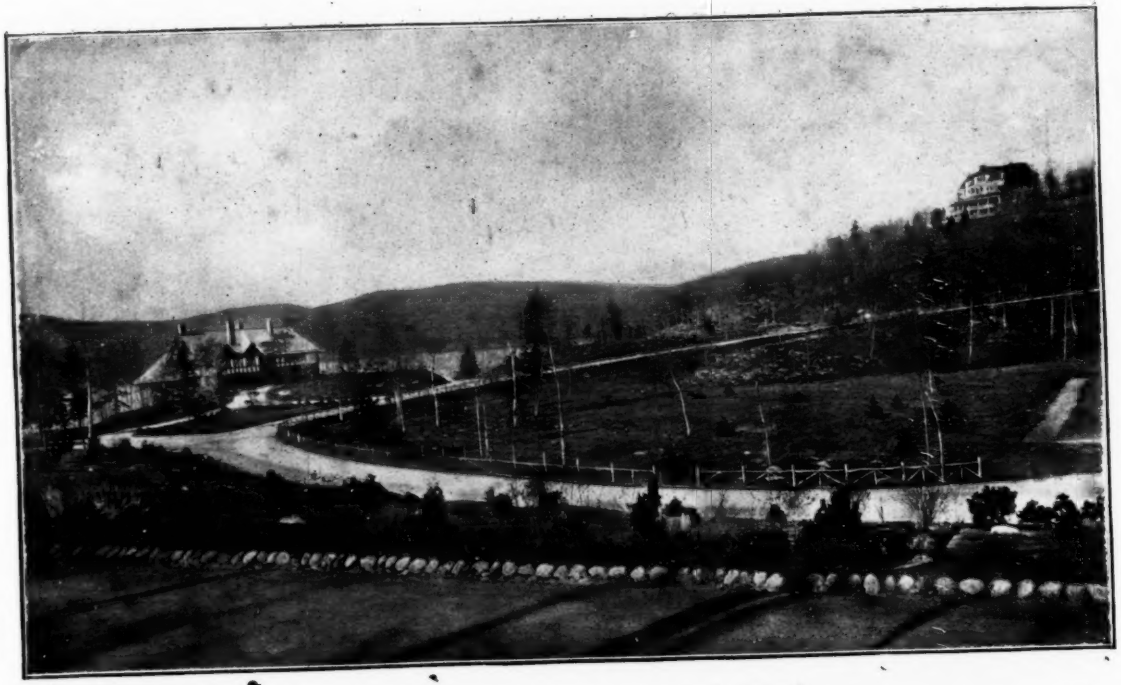
EAST LAKE ROAD AT "THE BREEZES," TUXEDO PARK.

The purity of the water in Tuxedo Lake is, also, one of the especial objects of care. In the sewers, where any approach the lake, where the chance of percolation might arise through defective sewer-pipe, cast-iron pipe is used, caulked and tested under hydraulic pressure. Compression manholes, check-valves, or gates, are placed on house connections for flushing under pressure. All stables near the lake are sewered, having leach-basins through which their wastes are filtered before entering the sewer-mains. The final disposition is at the extreme north end of the property, where chemical precipitation and filtration is being experimented with. As yet only copperas has been used; while the result has been highly satisfactory so far as eliminating the gas, and precipitating the sludge goes, still, lime or some other chemical will have to be used to give final and satisfactory results. The plant consists of four settling-tanks with a system of sub-surface irrigation pipes through which the sewage passes and finally is allowed to enter the living stream flowing into the Ramapo River. The effluent is quite clear, but not purified sufficiently.

The sewers are cleaned once a month, the grease-traps in some cases being cleaned every fortnight; the plumbing-work outside of the buildings, whether for water or sewer connections, is under the control of the Association, they, under the direction of their resident engineer and superintendent, doing all the work and making the final connections; no workmen not employed by the Association are permitted to touch the water or sewer-mains. Running-traps are vented in the manholes, and they in turn have a fresh-air inlet carried to such safe and convenient place as circumstances, and the owner, may permit, or seems advisable, the grease-traps being in some cases ventilated by pipes carried to the roofs of the houses. Particular care is taken, in cleaning these traps, to carefully seal the openings around the covers, that no gases may escape.

To resume a circuit of the grounds, after passing the triangle mentioned, is seen "The Breezes," the elegant home of Mr. James L. Breese. Here, as in some other instances, may be noticed the presence of the Tompkins Cove blue limestone, crushed very fine, for road and path dressing. While the color has a beautiful effect, with the fine lawns, it seems to lack perfect amalgamation with the graveled roads of the Park itself, making the effect rather too startling and pronounced.

Driving along East Lake Road, one passes through the only



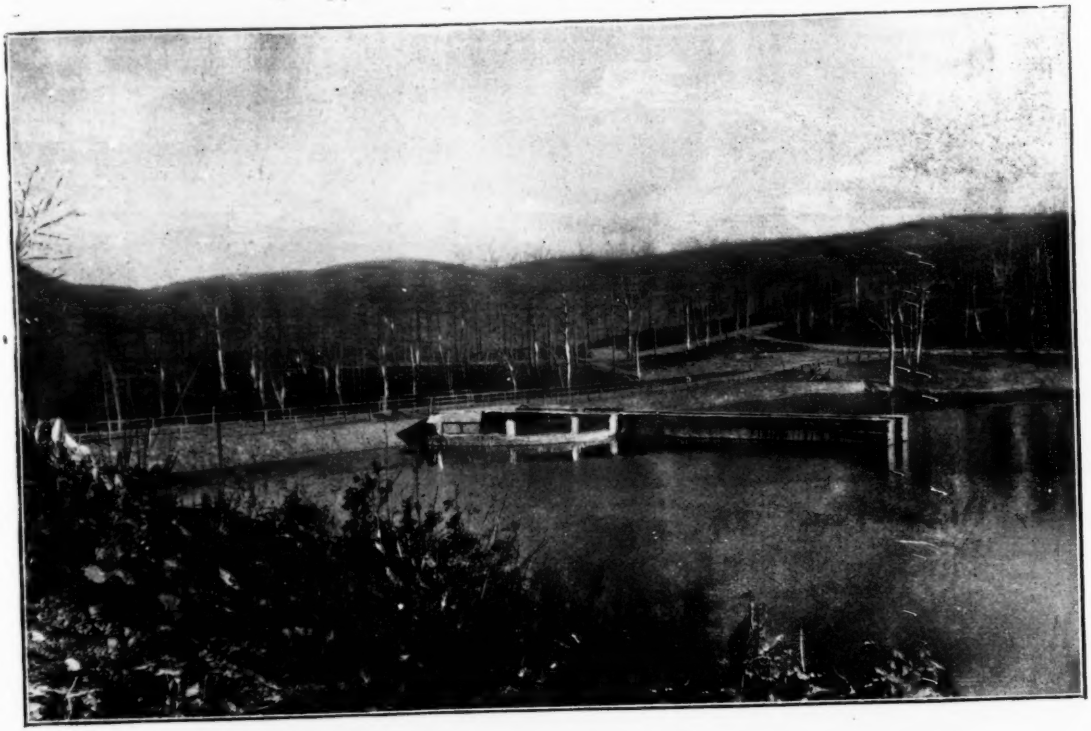
'VIEW LOOKING WEST OVER TRIANGLE AT MISS BREESE'S COTTAGE.'

thorough cut of any size made in the Park, the roadbeds generally being side-hill cuts, often in solid ledge rock. This route continues on the very edge of the lake. A broad, straight, hard and smooth road adds the grandest effect possible from this point to the Club-House, a quarter of a mile away. Extensive excavations are being made on the right, high up on a commanding bluff. When completed the mansion to be erected there will be a massive and striking affair, costing hundreds of thousands of dollars, yet only a "cottage" in name. It boasts of being the only house yet built here which will have a ground entrance from four of its stories. Mr. Charles B. Alexander is its owner, and its architect, a new one here, Mr. Joseph H. Taft.

Originally the way to the Club-House was over Tower Hill, making a long and steep journey. Now the road referred to is used entirely. In its location some of the most pronounced and rugged features have been brought to notice, a steep bluff and huge old hemlocks making a wild, rugged scene. The attention is at once riveted upon a fort-like wall immediately on the roadside and in close contact with the rocks and trees named; up through this wall ascends steps to another and still another wall of massive proportions, at the top a house, one story of stone, a roof joining it, broad piazza and large columns; comfort is the aim of the house, but what shall be said of its inharmonious effect upon the landscape? It may add character but not beauty. No one passes the next cottage, that of Mr. Frederick R. Halsey, without admiring his beautiful lawn, his flowers and the painstaking care of all details so essential to a charming place.

The grounds, drive, and Club-House are now before you, all controlled by the Tuxedo Club, which is entirely distinct from the Association. Here are the annex, the electric-light plant, the bathing-houses and pool, the fish-hatchery with its innumerable pools for the propagation of brook trout and black bass, the lawn-tennis courts, and the boat-house, all connected by roads and paths. Electric light is used in the Club-House, annex, manager's house, electric and steam-heating house and the Club stables.

Here is the head of Tuxedo Lake. At present the dam is finished as a broad macadamized drive, bordered by strips of sward and paths; the dam is of earth, much wider and two feet higher than the dam of by-gone days. A hundred years or more ago, when the London Company used the water for their furnaces at Ringwood, it was raised six feet higher than at present, the

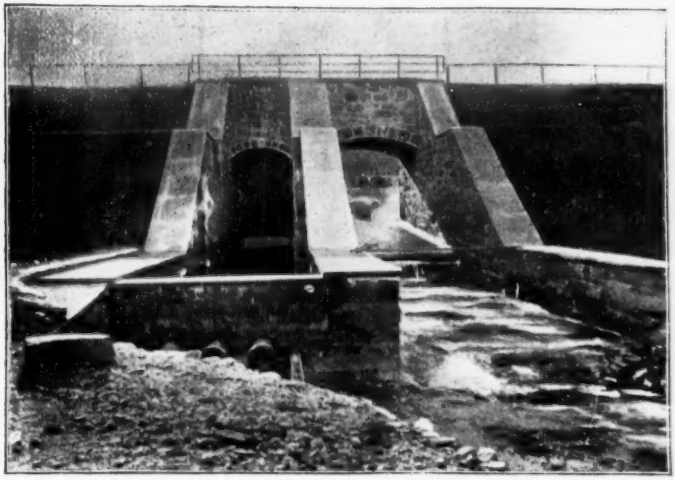


DAM FIVE, TUXEDO LAKE, LOOKING EAST.

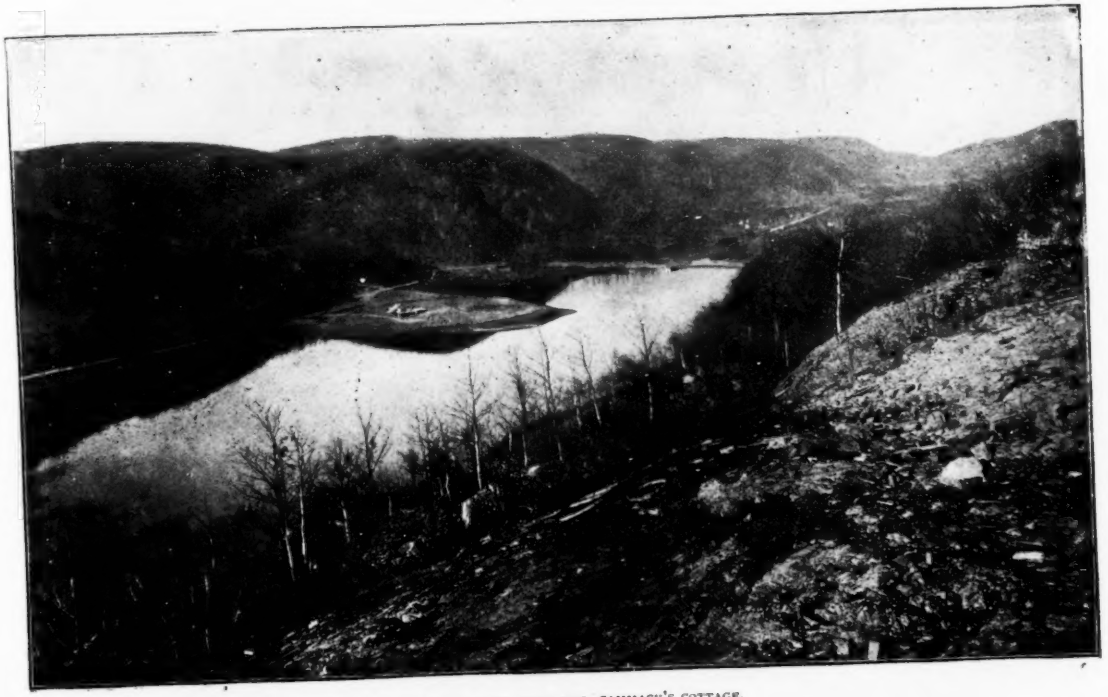
dam being of wood, thereby turning the flow toward the south with a head of four feet ; to-day the water at the south end of the lake runs into Tuxedo. At a subsequent date the reservoir capacity was under the control of the manufacturing interests at Ramapo, but at that time the supply was carried toward the north and down the Ramapo River, illustrating the peculiar fact that the lake is so located that its supply may be carried either north or south.

Among the improvements made on the borders of the lake are numerous handsome cottages, some costing almost a quarter of a million, standing out prominently. Stone walls have been constructed along the water edge to define more conveniently the water limits. The practical uses of these walls are apparent, but their harmony with the landscape is not apparent.

The great beauty of Tuxedo Lake lies in its exceptionally fine contours, its broad expanse at the north end, its narrow width at the middle of its length, bold sides, and very contracted area at the south end ; its coves and bays, and its precipitate sides of ledge rock. No marshy wet ground adjoins Tuxedo Lake to add miasma to its pure air, contaminate its waters, or compromise its beauty. Its area is about 300 acres, its greatest depth, sixty feet. The



DAM FIVE, OVERFLOW AND GATEHOUSE, TUXEDO LAKE.



WEE-WAH LAKE FROM MRS. CAMMACK'S COTTAGE.

evaporation from its surface is extensive. No large amount of water is supplied to it by streams, its supply being principally from springs within itself; two syphon pipes are used for the fish-hatchery, taking water at different temperatures from the lake for hatching the trout.

A small lake of about an acre and a half near the Club-House was found to be unsatisfactory in its character, and has been filled in at a large expense; a somewhat similar one was abandoned at Babcock brook. The outlet of Tuxedo Lake for any extraordinary flood is certainly too small, and at some day much damage will

WESTERLY VIEW OVER DAM ONE.

result from the inadequate conditions unless something is done for it.

Pond Three is an artificial lake principally used for a trout pond and skating purposes; on it terminates the toboggan slide, which, in recent seasons, does not seem to be as popular as when Tuxedo first opened. Dam Four is a well and substantially built structure, with core-wall and masonry overflow, having ample provision for drawing off the lake by gates at the base.

The largest piece of engineering work performed in Tuxedo is Dam Five, a rubble, masonry-core dam, about 375 feet in length,

ST. MARY'S EPISCOPAL CHURCH, TUXEDO PARK.

and thirty feet high; ashlar overflow, filter walls, and gate-house; it is an immense, and in part, unnecessary structure as planned, but the effect of the new sheet of water on the landscape is most charming; the lake covers about fifty-six acres, its irregular shape caused partly by the prominent peninsular-shaped Pigeon Grounds, where are weekly shot hundreds of pigeons by the best marksmen of New York and Tuxedo. The drive around this new lake is the longest level drive in the Park, and is very popular.

Standing upon Lookout Mountain, at the pretty rustic summer-house, one obtains a panoramic view of the valley of the Ramapo for twelve miles toward the north. Here is the only range of land at all used as farms, or cultivated; here and there are dotted houses and buildings of various kinds; the course of the Ramapo River as it winds through its tortuous course shining like a mirror in the green meadows; the Erie railway finding its way in graceful curves along its sides, adding character to the attractive valley. From this point also the Wee-Wah Lake is a feature of attention.

After a drive of two miles, we stop for a moment at the Summit Road summer-house, above the commanding sites and residences of Mr. James Brown Potter, the Japanese Cottage of Hon. J. M. Glover, and the cottage built by the late Managing Director of the Park, Mr. T. B. Baldwin, now owned by Mrs. John Wolfe. Towering above all these is the cottage of Mr. W. W. Watrous and from it is opened one of the grandest views of Tuxedo. But our destination is a point reached only by a bridle road, steep and long—the old log tower on Eagle Mountain, the hill at the west of the lake. From this tower is seen the finest landscape the Park affords. Almost at our feet, the mountain side being so precipitate, we see the lake stretching away to the north and the east ; on yonder high hill is the largest building yet here, the residence of Mr. Pierre Lorillard, Jr. ; that not yet completed to the west, the cottage of Mrs. Addison Cammack ; on the same range the cottages of Mr. A. M. Post Mitchel and Mr. Paul Tuckerman ; and on Tower Hill prominently in the foreground those of Mr. Henry J. Barbey, Mr. William Wetmore Cryder and many others.

A network of roads, of undulating hills, possession seems endless. Yet east and west are hundreds of acres used only as game preserves ; deer, English pheasants, wild turkeys, partridge and quail roam here undisturbed ; otters come up from the Ramapo, mink and raccoons silently find their way up the streams at times destroying fish ; foxes and opossums destroy the game ; occasionally a wild goose is seen ; ducks and the loon also stop on their journeys, now and then even a wild-cat meets its fate at the hands of a game-keeper, but civilization has advanced too far here, and the birds and beasts move farther away.

With all these primitive features and the rugged wildness, there are around you all the conveniences of a city home—water, sewers, good roads, stage service and police protection, lighted roads, and social features, all of the best that the country affords. Without doubt, in time in the southeast regions of the park where is now Mountain Lake, Delaney's Swamp and Bogg Meadow will be beautiful lakes and regions of equal attractiveness. It is to be earnestly hoped that the present liberal, enterprising, and capable President of the Tuxedo Park Association may be spared for years to come to still more fully develop and adorn this charming place, as he so well knows how.

THE RIGHTS OF THE LOWEST BIDDER.

WHAT CONTRACTORS WISH TO KNOW.

By Leicester Allen, A. B., M. E.

THE inquiries comprised in this article were suggested by a brief paragraph in the Architectural Department of THE ENGINEERING MAGAZINE for October. The paragraph referred to a decision of importance to architects and builders, and stated compactly that a Boston contractor, having been the lowest bidder for a contract covering the erection of a building for the Boston Chamber of Commerce, and having had his bid rejected, had sued for, and recovered damages amounting to $14,500 in the court of first resort; and that the case having gone up on appeal to the court of highest resort, the Supreme Court of Massachusetts, the judgment of the lower court was therein confirmed. As I could find no copy of the text of this decision in print, I corresponded with Mr. Robert M. Morse and Mr. Charles E. Hellier, counsel for the plaintiff, and from them obtained a typewritten copy of Judge Allen's opinion rendered in the appellate court, together with other particulars relating to the basis upon which the claim for damages was made up. These documents substantially confirmed the statement in the paragraph referred to which attracted my attention. At the same time, the information obtained suggests some interesting questions of practical import to contracting engineers, builders and architects, as well as to individuals, corporations, and building committees who give out contract work. The decision is substantially that the lowest *invited* bidder for a contract is entitled to recover damages, if the contract is not awarded to him.

The system of awarding contracts to competing bidders who base their estimates and proposals upon specifications prepared by supervising architects or engineers is so extensively practised, and concerns so many lines of business, that a statement of some abuses that have gradually crept into it, together with their legal remedies, and an epitome of the legal status of both parties to a contract based upon the acceptation of either a written or verbal estimate and proposal seem desirable. To this end, I am requested to write an article from the contractors' side which shall represent what information is desired, and, touching upon some abuses attending the

competitive system of bidding, propound certain questions suggested by the outcome of the litigation in the case of McNeil vs. The Boston Chamber of Commerce. I am informed that my article will be followed by one from a gentleman of the legal profession, who will further discuss the points I shall raise, in their legal aspects.

It appears, from the decision cited, that the lowest invited bidder has legal rights growing out of his invitation to bid. How is the lowest invited bidder to be legally identified? What, in the eye of the law, constitutes a "lowest invited bidder?"

Messrs. A., B., C. and D. are asked for estimates and proposals, each being furnished (as they are duly informed, and as they reasonably suppose) with a copy of the same specifications and drawings. In accordance with their invitation each, after a more or less exhaustive consideration of the specification, sends in a proposal. In so far as cost of material affects their estimates, we will suppose that all of the bidders—each being of good commercial standing—are practically on one level, any one of them being able to purchase the materials required at a price as low as the others can. As to cost of labor, they may not be able to arrive at the same conclusion; and, on this account, their bids may legitimately vary, but not very widely. Their estimates may also vary legitimately from the fact that one or more of them will be content with a somewhat less profit than the others; the profit desired being influenced by various commercial reasons, as the amount of work on hand, the desire, in a dull season, to avoid the discharge of workmen, etc. In these days of active competition the margin of profits has been so narrowed for all contract work that it cannot, with safety, be much reduced; for this reason, no very wide deviation in the bids of responsible houses can be expected.

The bids are opened and the contract is awarded to Mr. D. The rejected bidders, asking for the amount bid by Mr. D., are politely informed that this can be of no particular consequence to them, and the information is refused. Now, how are they legally able to ascertain whether Mr. D. was really the lowest bidder; or whether, through a preference growing out of something else than the sum named by him as his price for the work, the contract has been awarded to him, regardless of the rights of the "lowest invited bidder"?

Another case: Let us suppose the same bidders have competed as before, and that the contract has been awarded to Mr. D. In some way the rejected bidders obtain all the prices named, and find,

while the bids of Messrs. A., B. and C. vary only in so far as may be reasonably accounted for from ordinary commercial reasons, that of D. is so far below any of the others, that if he perform the work according to the specifications and drawings upon which the other bidders base their estimates, he must do so at a notable and inevitable loss. Let us suppose the rejected bidders to be suspicious that there is "a cat in the meal," and to quietly watch the progress of the work as executed by Mr. D., discovering, as the result of their scrutiny, that the work is either allowed to depart so far from the specifications as to greatly cheapen its execution, or that another and totally different specification is followed by the favored contractor. In this case who is the lowest bidder, and what are his legal rights?

This thing happens more frequently than the public generally supposes. The trick was played upon a firm for which I once made an estimate, the facts attending the occurrence palpably showing that a secret understanding existed between the architect and the contractor to whom the contract was awarded, and that all the others who were requested to estimate were invited simply to present a show of fairness to the building committee—if, indeed, the latter was not also a party to the trick. As further illustrating this point I will say that the estimate cited was for a steam-heating plant designed by the architect or by some one in his employ. Upon my suggestion to him that the design might be modified and thus much cheapened, without, in anywise, affecting its efficiency, I was curtly advised that any modification was out of the question. I was repeatedly told that all bidders were "on the same level"; they were "all to bid on the same thing and the lowest bidder would get the contract." Yet the firm to which the contract was awarded put in a plant differing from what was specified, both in materials and work, as widely as could well be possible. Cast-iron boilers were placed in the buildings instead of horizontal tubular boilers set in mason work, as was specified to other bidders; valves were used of a very much cheaper and poorer quality than the specifications called for; and the specifications were otherwise departed from in almost every particular. Was either A., B. or C., in this case, legally a "lowest invited bidder"? Suppose the lowest bidder to have been B.; what were his rights in the premises, and what course could he legally have taken to secure his rights?

Let us suppose another case—that in which two contractors each put in the same estimate, their bids each being lower than any

of the others. To whom, in this case, must the contract be awarded?

There is another phase of letting contracts to competitive bidders. Certain specifications are presented; several invited bids are made; one of them is substantially lower than the others. The contractor who puts in this bid is, it seems, legally entitled to the award of the contract, but he is now confronted with a formidable document—carefully prepared, iron-clad articles of agreement containing requirements and limitations not mentioned in either the specifications or the notice to bidders accompanying their invitations. Is the lowest bidder, in this case, obliged to sign such articles of agreement? Should not the articles of agreement simply coincide in all particulars with the specification, or be filled out and appended to the specification as the form in which all bids must be presented? Does the lowest bidder, in this case, make void his legal claim to the award of the contract by a refusal to sign articles of agreement which, as his legal counsel advises him, contain provisions not made plain in either the specification, the notice to bidders, or the letter inviting him to bid? The form of contract adopted by the joint committee of the American Institute of Architects, the Western Association of Architects, and the National Association of Builders, contains the following clauses:

"4. The Contractor shall, within twenty-four hours after receiving written notice from the Architect to that effect, proceed to remove from the grounds or building all materials condemned by , whether worked or unworked, or take down all portions of the work which the Architect shall condemn as unsound or improper, or as in any way failing to conform to the drawings and specifications, and to the conditions of this contract. The Contractor shall cover, protect and exercise due diligence to secure the work from injury, and all damage happening to the same by neglect shall be made good by .

"5. The Contractor shall permit the Architect , and all persons appointed by the Architect , to visit and inspect the said work or any part thereof, at all times and places during the progress of the same, and shall provide sufficient, safe and proper facilities for such inspection."

Suppose now that the accepted bidder has signed this contract, and that the person appointed to inspect the materials and the work during its progress, turns out to be one who seeks to obstruct the work by undue, useless, untimely and annoying inspection, or by arbitrary and unjust condemnation of materials, or of work which has been done strictly and honestly in accordance with the drawings and specifications. What is the contractor's remedy?

Under the conditions imposed by the clauses quoted has an inspector unrestricted and absolute power to reject or approve materials or work, so that he may wait until all the work has been

done before he rejects materials ; * or is there some equitable principle of law which screens an honest contractor in performing exactly what he expected to do—what he had just reason to expect when he made his proposal ?

In cases wherein several parties are requested to estimate upon work furnishing each his own specification, and wherein each estimates upon a different class of materials and different construction, who is to be considered legally as the lowest bidder, and what are his rights as such ?

In a case wherein several contractors have been invited to estimate upon identical specifications and drawings, and wherein some uninvited "dark horse" comes forward with specifications and drawings independently prepared, underbids all of the invited bidders, and has his offer accepted ;—is he legally the lowest bidder ? If not, what are the rights of the "lowest invited bidder" ?

Has an invited bidder, uninformed otherwise before making his bid, the presumed legal right to assume that the lowest bidder will have the contract awarded to him, unless the right to reject any and all bids is specifically reserved in the notice to bidders ?

These are points of interest, not only to contractors, but to all supervising architects and engineers, and to building committees. The writer's experience, with architects and engineers ranking high in their professions, leads to the unavoidable inference that the large majority of them are fair, just men, incapable of taking advantage of contractors who honestly carry out the provisions of their specifications ; unfortunately there are exceptions, but exceptions to integrity are much more numerous among contractors, and engineers, and architects are not to be blamed because they take every means to fortify themselves against "scamping." But it seems that the character, reputation and commercial standing of competing bidders ought to be ascertained before invitations to bid are sent out ; and that fairness and commercial, if not legal equity demands that, once the invitations are made, each bidder should stand on exactly the same level, except in a case wherein intervening commercial embarrassment or bankruptcy renders any one of the bidders incompetent.

There ought also to be some way of circumventing the "ways that are dark and the deeds that are vain," of the race of straw-bidders."

* The blank space may be, and sometimes is, filled out in such a way that either the architect or any one authorized by him shall have the power of approval or condemnation. Such was the form in the case of the firm alluded to.

The considerations presented to the jury in the case of McNeil vs. The Boston Chamber of Commerce, which, I am informed, presumably governed the jury in fixing upon its verdict, were that the plaintiff was entitled to the net profits which would have accrued to him had he been permitted to execute the contract. The reasonable gross profits were probably estimated at 10 per cent. (inferred from the amount of the verdict rendered) and, as the verdict is less than 10 per cent. of the cost of executing the contract, deductions were probably made of the value of the plaintiff's skill, supervision, and time, and the value of certain risks; as, the risk of loss in the rise of value of material, and the risk of indemnity for such injuries to workmen in the employ of the contractor as for which he would be liable.

Mutual protection is, I take it, the basis of all equitable contracts. On the one hand, the supervising architect or engineer feels the necessity of fortifying himself against the possibility that a contractor may slight his job. It is for this that specifications are prepared, and that an honest, reasonable and just inspection, at proper times, is indispensable. I submit, on the other hand, that the proper time for inspection of materials is when they are delivered. It is manifestly unjust that a contractor who has, in good faith, supplied a quantity of costly materials, supposing them to fully accord with the specifications, but which, unknown to him, may, perhaps vary therefrom in some minute particular, should be allowed to erect these materials, at additional cost, only to lose on both materials and work, through the final condemnation of the materials, after the work is completed.

THE ANSWER OF THE LAW.

By Charles E. Hellier, A. B., LL. B.

THE rights of the lowest bidder are to be determined in each particular case by the contract, either expressed or implied, entered into between the party who invites bids and the bidder who accepts the invitation. The lowest bidder can have no rights other than those agreed upon with the party to be bound. A public advertisement, by newspaper or otherwise, or a private invitation to a selected number, has never been held by any court of last resort in this country or in England to imply a promise that the lowest bid should be the bid selected ; but such

advertisements or invitations for bids are considered as requests for offers, and no contract is created and consequently no rights exist until an offer is accepted.

In some localities, where a certain person or firm has been found to excel all competitors in a particular line of work, injustice is sometimes done by a competition being asked for with the sole purpose of acquiring a basis of figures upon which to make a contract with the excelling person or firm. If the bidders had no knowledge that the competition was not *bona fide* and could show that their bids were obtained solely for the purpose of making the lowest possible contract with a previously chosen party, they might recover damages for the time spent in preparing the bids; but as in most cases of this kind the existence of such a state of affairs is an open secret, would-be bidders have the choice of remaining out of a competition which exists in name only, or of putting in a bid in the hope that it may prove so low that the more fortunate rival will not care to come down to it; a hope which generally proves futile, as usually he is better equipped to do the work than the other bidders, and is able and willing to make as low terms as any one rather than give up the job.

In the recent Massachusetts case of McNeil vs. The Boston Chamber of Commerce the facts were as follows: The Boston Chamber of Commerce having voted to build, a building committee was appointed who soon after their appointment selected as their architect one of the leading firms of architects in Boston. After a consultation between the building committee and their architects, the committee invited five of the leading builders in that part of the country to submit bids for the new Chamber of Commerce building, upon plans and specifications made by their architects. Four of these five builders after inspecting the plans and specifications and the notice to bidders attached to the specifications, declined to submit bids. The building committee then called a meeting of the builders at the rooms of the committee at which all five builders were present, as were also the committee and one of the partners of the firm of architects; the four builders said they would not bid unless the committee would agree that the lowest bidder should have the contract, if the building were built substantially in accordance with the plans and specifications then made by the architects; at the trial before the jury the four builders testified that the committee agreed to the proposition. Some other matters were discussed at the meeting,

and the builders went away satisfied; in a few days they again called at the office of the architects and got copies of the specifications and made bids; attached to the specifications, being the first page thereof, was a "notice to bidders." This was the same notice which was attached to the specifications seen by the builders before their refusal to submit bids, with some of the modifications agreed upon at the meeting, noted upon it. Among other things the notice to bidders stated "the building to be let to the lowest bidder;" and farther down the page "the building committee of the Boston Chamber of Commerce reserves the right to reject any and all bids." By agreement the bids were opened in the presence of the five bidders; McNeil's was the lowest. The committee announced that they reserved their decision; several days afterwards they requested McNeil to make certain reductions in his bid, some of which he did make, but others which he was asked to make without any corresponding change in the specifications he did not feel as if he could make, and so informed the committee. The next day the five bidders received notice from the building committee that all the bids were rejected and they were asked to submit bids in a new competition on plans and specifications substantially like those already bid upon. McNeil immediately wrote to the building committee claiming the contract by virtue of the oral agreement entered into at the conference of the builders with the building committee, to-wit: that the lowest bidder should build the building if it were built substantially in accordance with the plans and specifications then furnished by the architects; the three other builders who had at first refused to bid, now refused to submit new bids, and insisted that McNeil alone had the right to the contract to build the building. The building committee ignored McNeil's claim and proceeded to make a contract with the party to whom the other builders were suspicious the architects intended the contract should eventually be awarded after the form of a competition had been gone through with. (In justice to the architects it should be said that they testified that they had no such intention.) The specifications, made a part of the contract, were substantially the same as those figured upon by McNeil, the principal changes being a reduction in the number of piles under the foundation, the architects having discovered that more than were necessary had been required in the specifications as first prepared, and a change in the material of the façade or outside wall of the building.

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At the trial of the case in September, 1890, in the Supreme Court, before Mr. Justice Holmes and a jury of more than average intelligence, all of the builders, except the one to whom the contract was given, testified that at the conference between the committee and the builders, the committee agreed that the contract for the building, if built, should be given to the lowest bidder. The representative of the builder to whom the contract was given who was present at the conference was called by the defendant and sworn, but was not put on the witness stand. The building committee denied that they had agreed to give the building to the lowest bidder, and insisted that they had never given up the right to reject all bids reserved to them in the notice to bidders attached to the original specifications, which clause appeared also in the modified notice to bidders attached to the specifications figured on by McNeil. The defendant further denied the authority of the building committee to make a contract for the building without the approval of the board of directors, and said that the board of directors had not given such authority and had not approved any contract, if any were made. It was denied also that the contract as finally awarded was for a building substantially the same as that figured on by McNeil. By consent of parties, five questions of fact were submitted to the jury; they were as follows:

1. Did the committee on building purport to make a contract on behalf of the defendants by which they agreed to accept the lowest bid in case the building was built substantially in accordance with the plans and specifications submitted, without reserving the right to reject bids in that case?

2. If such contract was made, was it approved by the directors?

3. If such contract was made, was it within the ostensible authority of the committee?

4. Was the building as finally contracted for, a building substantially in accordance with the said plans and specifications?

5. If the plaintiff is entitled to recover, what are his damages?

The jury answered "yes" to the first four questions and placed the damages at fourteen thousand five hundred dollars McNeil's original bid was $400,000 which was reduced to $370,280 to correspond with certain changes in the specifications. The court ruled that as a matter of law the plaintiff could not recover and reported all the evidence in the case to the full bench, who decided that the jury were justified in their findings, and that the fact that McNeil

figured on specifications to which was attached a notice to bidders containing a clause reserving to the committee the right to reject all bids, did not vary the terms of the oral agreement made at the conference, that the lowest bidder should have the contract; accordingly they ordered judgment for the plaintiff for the amount of the verdict of the jury.

But the case comes very close to the line as will be seen by the following case decided by the same court some years ago. A town passed a vote at town meeting directing the selectmen to build a sewer of certain dimensions, the job to be advertised in the newspapers and let to the lowest bidder. The board of selectmen accordingly advertised for proposals for building a sewer, the advertisement directed persons desiring to bid to call at a place designated for specifications of the work to be done. A., in answer to the advertisement called and received the specifications and put in a bid on them. The specifications contained a clause reserving to the selectmen the right to reject all bids. A.'s bid was the lowest of several bidders, but all the bids were rejected by the selectmen as being too high. A. brought suit against the town and obtained a judgment, but upon appeal the Supreme Court of Massachusetts set the verdict aside and held that the plaintiff had no cause of action; the decision was made upon the ground that the dimensions of the sewer called for by the specifications did not correspond with the dimensions of the sewer which it was voted at town meeting to build, but the court went on to say that even if this had not been so, the fact that A. had made his bid upon specifications containing a clause reserving to the selectmen the right to reject all bids was conclusive against A.'s right to recover, as the specifications were essential to and constituted a part of the contract, and A. having figured on them he must be held to have assented to the terms contained therein.

Having been requested to discuss, from a legal standpoint, certain questions raised by Mr. Leicester Allen in the first part of this article, they will be taken up so far as feasible in the order raised by Mr. Allen and reviewed briefly in the light of a recent and quite exhaustive search of the authorities on the subject of the rights of bidders and contractors. The question is asked, "What, in the eye of the law, constitutes a *lowest invited bidder?*" As a bid can be high or low only as measured by some fixed standard it necessarily follows that all bids in an invited competition must be upon the same specifications and conditions, and the

lowest legal bid in an invited competition is the one which names the lowest price for all the requirements of the specifications.

The next query is if A., B., C. and D. upon an invitation put in bids on the same specifications and the contract is awarded to D., how are the others to legally ascertain whether D. was the lowest bidder? As has been pointed out earlier in this article A., B. and C. have no legal rights by virtue of their having put in bids unless the person asking for the bids has agreed that the lowest bidder shall have the contract; if that has been done, an agreement that the bids should be opened and read in the presence of all the bidders would in all probability obviate the arising of any question of this nature; but in case such a question should arise the remedy of A., B. or C. would be an action at law against the person who invited the bids, alleging the agreement that the contract should be given to the lowest bidder and claiming that the plaintiff's bid was the lowest and asking for the damages suffered by reason of the contract not being given him; or an application might be made to a court of equity praying for an injunction restraining the party who invited the bids from executing the contract with D. and asking that the court order the contract to be executed with the lowest bidder as agreed. If there is an agreement that the lowest bidder shall have the contract and the contract is awarded to D. whose bid did not conform to the specifications, that one of the other three A., B. or C. whose bid was the lowest and in conformity with the specifications would be entitled to the contract and would have a good cause of action at law to recover damages for the non-execution of the contract with him. In case two bids in such a competition prove to be for the same amount, and lower than all of the others, the contract could not be awarded, as the agreement was that the lowest bidder should have the contract, which being impossible in this case, becomes void, for impossibility of enforcement. A lowest bidder who is by agreement to that effect, entitled to the contract, cannot be compelled to sign any articles other than those agreed upon, nor will he waive or render void his legal rights by a refusal so to do; one party to the contract cannot add to its terms without the consent of the other.

The contractor's remedy for unreasonable inspection and a consequent withholding of the whole or a part of the contract price is an action of contract to recover the price agreed upon. The issue of fair inspection is then directly raised, and if the work or material can be shown to reasonably comply with the requirements of the

specifications, the contractor will be entitled to receive the amount withheld. Inspection must be reasonable and made at a proper time or else the contractor should receive the contract price. In matters purely of taste such as for example the fit of a suit of clothes, or the style of a carriage if the agreement is that the work shall be done "to the satisfaction of" the purchaser it is a complete defense to an action to recover the price if the defendant says "I am not satisfied" and he may be as whimsical and captious as he chooses, but where work is done or materials furnished according to specifications, and inspection is stipulated for, the inspection must be reasonable, and the contract price may be recovered if it can be shown that the work or materials reasonably fulfil the requirements of the specifications; if there were no specifications it is sufficient to show that the work or material was reasonably fit and proper for the purposes intended. For example, A. agreed to furnish and B. agreed to buy a million of brick for sewer work, the brick to pass C.'s inspection, the work being done for C., by B. under contract; an inspector employed by C. condemned the brick as unfit for the work. A. brought suit against B., showed by expert evidence that the brick were suitable for the work, and also that at about the time that the inspector condemned the brick there was a fall in the price of brick, so that B. was able to purchase of other parties for less than he had agreed to pay A. It was held in this case that A. could recover damages of B. for failure to take the brick, although they had been condemned by the inspector.

Where the specifications bid upon are different in each case, there can be no competition, and consequently no lowest bidder, within meaning of the term as used in this article. The lowest bidder as was stated at the beginning of this article has no rights simply by virtue of his bid being the lowest; his rights, if any exist, must rest upon a previously made agreement. There is no doubt that in many cases competitions are unfair and contractors spend fruitlessly much valuable time in preparing bids for them; but there is no protection for them in the law, except for loss of time, where fraud can be proved, unless they first protect themselves by some such agreement as the builders in the McNeil case forced the building committee of the Boston Chamber of Commerce to make. Such an agreement protects both parties.

THE PAPER-MAKING INDUSTRY.

By James F. Hobart.

THE proposed exhibit by the paper-makers at the World's Columbian Exposition will mark a wonderful advancement in this branch of manufacturing, which is now fifth in the list of American industries, having risen from the tenth place since 1880. It is important not only in its magnitude, but, to quote the motto of a leading paper-trade journal, "The consumption of paper is the measure of a people's culture." Without cheap paper the invention of printing could have benefited the world but little. The newspapers, read by everybody and contributing to the general intelligence and advancement, are enabled to exist only by means of the cheap cost of the millions of pounds of paper they use every year. So with the cheap and attractive-looking school-books, so essential to popular education. Our progress in pictorial art has been dependent upon the progress of paper-making. Photographers were obliged, until recently, to import from Germany the paper used in their work, our own manufacturers being unable to assemble the necessary conditions of material, water and workmanship for the production of paper suitable for silver-printing.

A process has now been perfected in this country whereby a very ordinary paper is coated with a thin surface of sulphate of barytes and answers admirably for photographic use, bringing out, in the finished picture, a wealth of detail formerly unknown in the art, it being lost in the texture of the paper employed. The use of paper as a cheap material for curtains, wall-paper and other house decorations has aided to make the homes of the people more attractive. Finally, the useful arts are beginning to depend largely upon the paper-maker. Thus the present speed and safety of railway travel owes much to the invention of the paper car-wheel, which combines strength and elasticity to a higher degree than any other material so far available. The building trades also use paper extensively, while commerce is facilitated by its use for wrappings and packages.

The production of paper is perhaps more closely regulated by the law of supply and demand than any other manufacturing pro-

cess. In the earlier days of paper-making there was little demand for it, as it was necessary either to write books by hand or to print them from engraved plates. The invention of the printing-press created the first demand for paper which caused its manufacture to become a profitable industry. The hand method of paper-making was followed for many years and discontinued only upon the invention of the cylinder press. This invention gave such an impetus to the distribution of printed matter that hand paper-makers were unable to supply the demand; hence a new order of things was inaugurated and machinery for the making of paper was perfected with great rapidity. Inventive ingenuity of the highest order is constantly at work to discover other uses for paper, while the manufacturer and the inventor of paper-making machinery are straining every energy to improve the quality of the product, to cheapen production or to provide special grades for new uses. Judging from the still undiminished flood of inventions it would appear that the industry is yet in its infancy as compared with the influence it is destined to exert on the comfort, intelligence and advancement of the human race.

The United States has a capacity for producing about 15,250,000 pounds of paper annually, not counting the idle mills of which at present about 70 are reported, out of a total of 1180. Of this enormous product some 3,735,000 pounds are used in printing newspapers and books, and 212,800 pounds more go to help bind the books printed. It is estimated that 498,000 pounds are consumed by the building trades; 3,176,000 pounds of wrapping-paper are used, and 590,000 pounds of writing papers. An important item is the production of nearly 1,600,000 pounds of press, straw and wood-pulp "boards." The production of "artificial leather," fortunately for the purchasers of shoes, has been decreasing since 1884, when 129,000 pounds of this material were produced. The most rigid economy is practised in paper-making; hence the high degree of mechanical skill and executive ability connected with this industry as compared with the cost of the product. It may be mentioned that large mills, making over fifty tons of "news" every twenty-four hours, often contract to supply their entire product to a single large newspaper-publishing house, at a price as low, for instance, as 2.9 cents per pound, which is paid by one New York journal of large circulation.

The growth of the production of paper in the United States will be seen at a glance in the table on the following page:

In 1881	5,315,400	pounds.
In 1883	6,949,800	pounds.
In 1884	7,867,830	pounds.
In 1885	8,147,060	pounds.
In 1886	8,357,480	pounds.
In 1887	8,957,830	pounds.
In 1888	10,091,130	pounds.
In 1889	12,224,480	pounds.
In 1890	13,561,180	pounds.
In 1891	15,219,580	pounds.

While this would seem a large production, it is exceeded somewhat by Germany, while of course large amounts are produced in Great Britain, France and other countries. There are indications, however, that the United States will lead the world in the production of paper before the end of this century. Already we are exporting paper at a steadily-growing rate. The following item has been extensively circulated in the British daily and weekly newspapers and trade journals :

"The English paper-makers are apparently a diminishing race. More and more foreign paper is being used in England week by week, from Germany, America and Sweden. There are no less than 1443 paper mills in Germany, while there are only 352 in the United Kingdom. It is the old story of the sit still and do nothing habit, indulged in year in and year out, while Continental rivals are energetically working to beat the English maker out of the field, both as regards price and quality."

The earliest paper manufacturers of which we know were hornets and some kinds of wasps. Like most manufacturers to-day these insects make their paper entirely of wood, an industry which they perfected while their human imitators were satisfied to use rags, jute and other fibrous material. The art of paper-making long remained in so crude a state that only the best fibre-producing material could be used. Linen rags were the only source of material, and even now the best paper is produced from clippings of new linen cloth.

The earlier processes of modern paper-making consisted of reducing the rags to a pulp so that fibres from .01 to .02 of an inch in length could be separated from each other. This process is continued to the present day. The rags, after having been reduced to mere fibres, became what is known as pulp or "stuff." It was mixed with an excess of water and from a vat full of the mixture a certain portion was dipped into a sieve. Most of the water ran out through the meshes of the sieve, leaving the fibre behind

VIEWS IN A PAPER-MILL.

in the form of a thin coating upon the bottom of the sieve. A dexterous shaking motion was imparted to the sieve by the paper-maker while the water was running out. The fibres arranged themselves more or less parallel, according to the manner in which the sieve was shaken and the speed with which the water left it. The quality of the paper depended largely upon both the condition of the fibre and the skill with which it was manipulated in the sieve and after leaving it. When the water had drained out, the paper-maker turned the sieve upside down, dropping its contents in the shape of a thin sheet of unfinished paper upon a board placed to receive it. The paper was then pressed, dried and finished between heavy iron rollers.

Several minor industries sprung up in connection with the first enormous demand for paper. Among these industries that of rag-picking and collecting was perhaps the most profitable. The country tin-peddler owed his success in business largely to the demand for paper stock. For many years his cart was seen wending its way among the hills and rocks of New England and the streams and fields of Ohio and the Middle States. Another step in the advance of paper-making has dealt a death-blow to the tin-peddler and his picturesque cart. The increased use of wood-pulp has killed his business and relegated his broom-decorated vehicle to the past, where the hand paper-makers' sieve has preceded him. Another branch industry, created and promoted by paper-manufacturing, is the preparation of bleaching powder. Many thousand casks of this chemical are imported annually; to the discredit of the United States it must be said that very little if any of this substance is made within her limits.

Since the use of wood-pulp has become so extensive, and the rag-picker and tin cart have disappeared, but few domestic rags are used in the manufacture of book and news paper. For writing paper however, and the better class of ledger paper, linen rags still hold their kingdom and nothing has appeared to supplant them. Paper may be made from all wood, as indicated by the daily issues of the New York *World* and *Herald*, and the Boston *Globe*. Many of the rags used are pickings from the streets of foreign cities, mostly from China and other densely-populated countries where labor is so cheap that it pays to collect rags, which in this country are not worth what it costs to gather them from the streets. Hundreds of thousands of bales of rags from Egypt have been made into paper. These rags are technically known to the paper-maker

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as "Blue Egyptians." They are packed in iron-bound bales and arrive here highly scented with sassafras and other essences.

In a paper-mill, rags are thrown into a machine consisting of a wooden roll, covered with projecting iron spikes, revolving inside of a wooden frame which carries several rows of similar spikes. A wire netting is placed underneath the revolving roll, and as the rags are thrashed back and forth between the several rows of spikes they become thoroughly cleansed of dust; hence the machine is known as a "duster." The rags are next caught upon a belt or apron and carried into the "rag-room," in which they are thrown upon tables where women and girls assort them. Large scythes are affixed to each table for cutting off buttons and ripping up seams. Any valuables found among the rags belong to the finders.

All woolen scraps are carefully removed, for wool-fibre is of no earthly use in making paper. The rags go next to the "cutter" which cuts them into small scraps. The color in them must be discharged, for which purpose boiling in lime-water is resorted to. When bleached the rags are ground until the fibres are nearly torn apart, when they are called "half stuff." It has a yellowish tinge, like unbleached cotton or linen fabric. To whiten it a solution of bleaching powder is allowed to percolate through it in "drainers." The "half-stuff," after this process, is further disintegrated by machines called "beaters," after which the material passes into machines which form it into sheets and rolls. The "stuff" passes under two brass bars which regulate its depth; thence along a wire screen containing 1600 meshes to the square inch. This screen is known as a Fourdrineer wire.

The machine takes its name from the inventor of this wire and is called a Fourdrineer machine to distinguish it from the earlier form of paper machine technically known as a "cylinder." The water with which the "stuff" is diluted forces its way through the wire cylinder and is drawn out by a pump, leaving a coating of paper more or less thick upon the outside of the wire cylinder, precisely as it formed upon the top of the old paper-maker's sieve. An endless felt comes from a cylinder which is located out of sight in the rear of the picture, and the wet paper film is led away, carried off upon the felt, and an endless sheet of paper is made instead of the small sheets turned out by hand methods.

At the further end of the wire screen, in the Fourdrineer machine, a roll covered with brass wire, called the "dandy," runs on top of the paper. It is here that the distinctive marks given to

paper are impressed within its substance. If the paper is to be "laid" or "wove," the requisite dandy roll must be placed upon the machine, the only difference being that in woven paper, the dandy roll is covered with wire netting, while the laid paper has a dandy roll covered with wires "laid" close together, so as to impress a series of short parallel marks upon the soft, wet sheet of paper which passes underneath the roll.

As the paper passes beneath the dandy roll it also travels over some "suction boxes." These are covered with brass plates pierced with many holes close together. A pump is employed to maintain a partial vacuum in the suction boxes, and much of the water is speedily removed from the embryo paper. At this point the paper is able to "go it alone," and is transferred to a felt which carries the wet sheet through other rolls, which press it into still firmer shape and expose it to the air, where it becomes slightly drier and considerably stronger. The paper next travels through another set of press rolls, thence upon a canvas felt, around large cylinders filled with steam, where the paper is dried and assumes a complete though not smooth condition. Two or three stacks of iron "calender" rolls are next encountered, where the paper receives a certain degree of finish, and is ready to be wound upon reels or cut into sheets.

There are several methods of "finishing," which means putting the paper into quires, reams, bundles and bales required by the dealer and consumer. The paper intended for United States revenue stamps is cut into small sheets, counted many times to make sure that the exact number desired is supplied. During the entire process of manufacture, this paper is in charge of a Government superintendent and a corps of *well-paid* watchmen. Every process from "half stuff" to finished paper is supposed to be at all times under the eyes of the watchmen and they are presumed not only to prevent the paper from being stolen, but also to prevent wood pulp and other cheaper stock from getting into the paper. It is finally packed in stout cases, fastened up with hoop iron, sealed with the United States Treasury Seal and shipped to Washington. There are many other varieties of paper, which go through processes both similar and different to those here described, but taken as a whole the production of paper from rags and poplar wood to the finished product is much as described above.

SEWAGE DISPOSAL IN THE UNITED STATES.

By George W. Rafter, C. E.

THE modern movement of population into cities has produced changes and created conditions of which our fathers hardly even dreamed. In the matter of sewage disposal these changes are exceedingly marked, and our urban populations of to-day are confronted in many places with the problem in its most aggravated form. The lake cities began by taking water supplies from the lakes on the shores of which they are situated, at the same time irrationally turning sewage into the bodies of water from which the public supply was derived. This has led at Chicago and Cleveland to expensive extensions of water-supply intakes in search of unpolluted water, and the end is not yet. On the great inland rivers the sewage of one city, after flowing a few miles, is pumped out for the water supply of another, with the result that the diseases produced by drinking sewage-polluted water have increased steadily among such populations in a ratio proportionate to the increase of sewage contamination. The remedy clearly lies either in seeking an unpolluted source of water supply or in purifying sewage before discharging it into the running streams.

In a paper on "Epidemics and Water Pollution" in the May number of THE ENGINEERING MAGAZINE, the present writer defined the right of every person using a natural water-course as the source of a water supply to receive the flowing waters, at the point where taken, pure and undefiled. The argument submitted gains confirmation at every hand, and without further discussing the general question it may be assumed as settled that the responsibility of purification rests upon every community, manufacturing establishment, public institution, or individual whose sewage-outfall is into a stream, pond, or lake which either is or may be the source of a public water supply, at any point fairly within the influence of the inflowing sewage. The question at once arises as to the legitimate limit of influence, and this question is definitely answered by some experiments on the vitality of the germ of typhoid fever, detailed by Hiram F. Mills, C. E., in the recently published Twenty-second Annual Report of the Massachusetts State Board of Health.

In the month of November, 1890, the Massachusetts health returns indicated that the number of deaths by typhoid fever in

Lowell far exceeded that of the whole city of Boston. The returns showed a rapid increase at the same time in Lawrence, and as no similar increase appeared in other cities, the State Board made the matter the subject of special investigation in these two. Lowell has a population of 78,000, Lawrence 45,000, and Boston about 448,000. Lawrence and Lowell are both on the Merrimac, Lawrence being nine miles down the river from Lowell. Both cities take their water supply from the river, and the crude sewage of Lowell is further discharged into the same stream, a short distance below the Lowell water-supply intake. A probable cause of contamination of the Lowell water-supply was found in the discovery of the discharge of the dejections of typhoid patients into Stony Brook, three miles up the stream from the Lowell water-works intake. It was found that such discharge was followed in proper sequence of time by a rapid increase in the number of deaths from typhoid in Lowell, the increase there being further followed by an alarming increase in the number of deaths from typhoid in Lawrence. In December bacteriological examinations of water drawn from the service-pipes in Lawrence resulted in finding the bacillus of typhoid in the Lawrence supply.

In connection with the Massachusetts Board's investigation of the endemics of typhoid at Lowell and Lawrence, the practical questions are at once raised as to (1) whether the numerous cases in Lowell may be justly ascribed to the known contamination of Stony Brook above the Lowell water-works intake ; and (2) whether the cases at Lawrence are also due either to the same cause, or further to an accession of typhoid germs in the water of the Merrimac River from the sewers of Lowell, which presumably received the dejections of many persons suffering from the disease in that town. The answer to both questions as given in the Report is a decided "yes," and we may now inquire whether typhoid germs which grow in the human body at blood heat will survive, in water only a few degrees above freezing, long enough to pass in the ordinary flow of the river from the Lowell sewer to the Lawrence intake ; then, through the distribution pipes to the services, into the homes, and finally into the bodies of the citizens of Lawrence. The temperature of the river water in November, 1890, was from 45° to 35° F. Taking the mean velocity of the river, the time from the Lowell sewer outfall to the Lawrence water-works intake is eight hours. Entering the reservoir the same day the water would certainly go to the consumers through the service pipes in from a

SEWAGE DISPOSAL WORKS AT EAST ORANGE, NEW JERSEY.

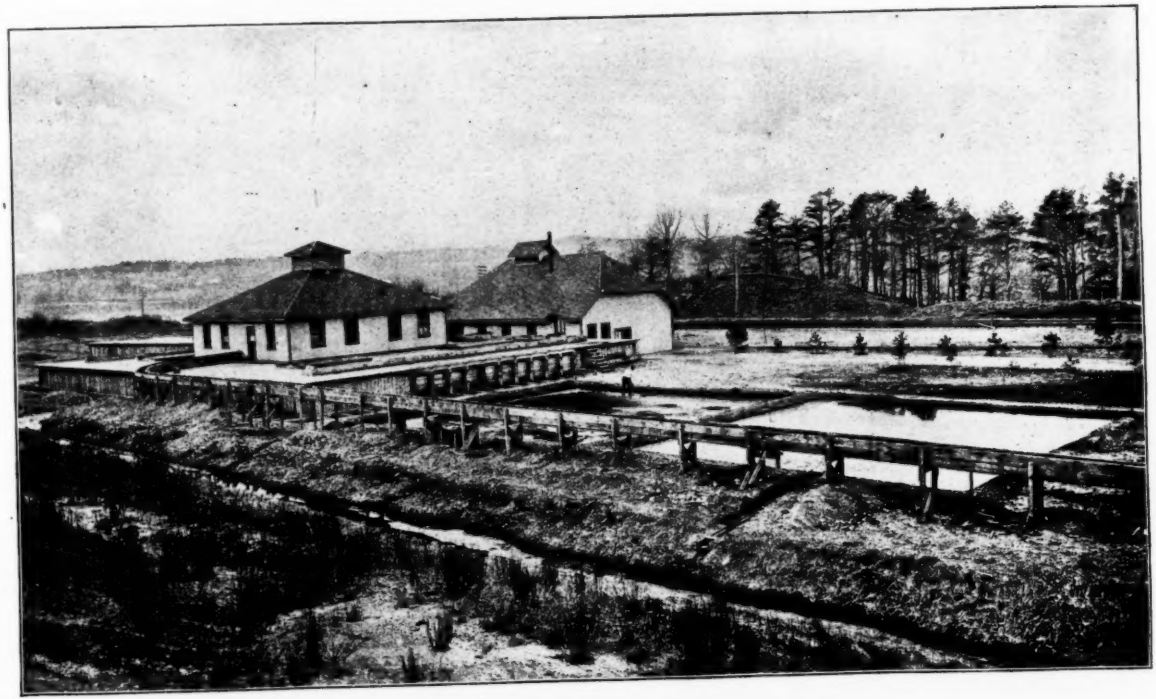
week to ten days, and the inquiry is limited to finding out whether the typhoid germs would live from seven to ten days in Merrimac-river water when at a temperature of from 45° to 35°.

To settle this question the Massachusetts Board experimented by inoculating water from the Lawrence service-pipes with typhoid germs and keeping it in a bottle surrounded by ice, at near the freezing point, for a month. Each day one cubic centimeter was taken out and the number of typhoid germs therein determined by the usual culture methods. The number was found to decrease from day to day, although some survived twenty-four days. On the first day there were 6120 germs; on the fifth day there were 3100; on the tenth day, 490; on the fifteenth day, 100; on the twentieth day, 17, and on the twenty-fifth day, none.

It appears then that in the Merrimac River the limit of influence of the sewage of Lowell is fairly the point reached by the flowing water in twenty-five days after passing that city, the effect of dilution in reducing the danger not being taken into account. The Merrimac River flows the nine miles from Lowell to Lawrence in eight hours or at the rate of $1\frac{1}{8}$ miles per hour. Twenty-five days are 600 hours, and it is accordingly found that a flow of 675 miles must occur before the Merrimac water could be considered perfectly free from the typhoid germs in the month of November. Enough is known of the persistency of vitality of the typhoid germ to justify the assumption that the legitimate limit of influence in this stream would be certainly as great as indicated in the foregoing. In a lake or pond where the conditions are different the limit of influence will usually be more restricted. Thus the general conclusion is derived that unpurified sewage should never be discharged into a stream used as a water supply at any point below the sewage inflow, without either purifying the sewage or the water supply. Let us consider the approved methods of purifying sewage.

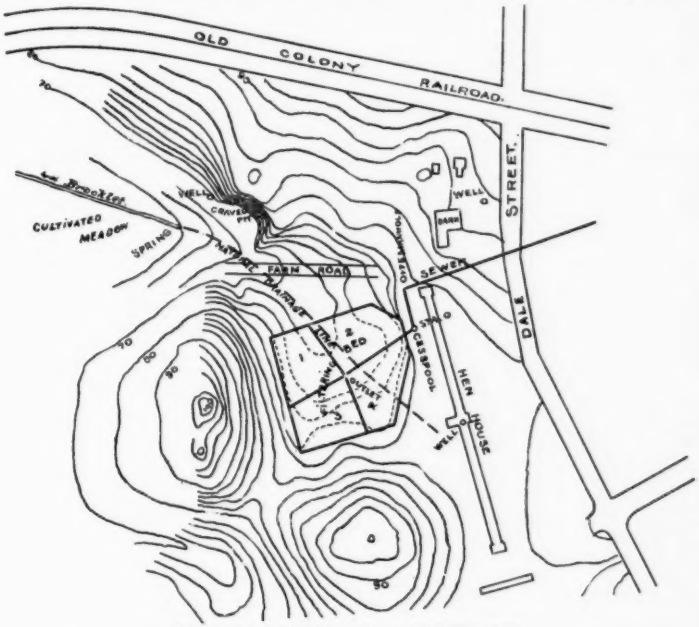
The aggregation of large populations on limited areas, long ago forced the question of stream pollution and sewage purification on municipal authorities in Europe, and the various processes have developed to a considerable degree of perfection in England and on the continent. Experience there indicates four methods of purification, as for instance, either by sewage irrigation, intermittent filtration, chemical treatment or by some combination of the first three.

In sewage irrigation the crude sewage is distributed by suitable carriers over cultivated land and utilized in the growing of crops.



MYSTIC VALLEY SEWAGE WORKS.

The general rule is one acre of land for each hundred people contributing. An example of this kind of purification was carried out at Pullman, Illinois, in 1881. This town is fourteen miles south of Chicago on the west shore of Lake Calumet, about six miles from Lake Michigan. Lake Calumet is a shallow body of water from one to eight feet deep, three miles long and about 1½ miles in width.



INTERMITTENT FILTRATION AREA, MEDFIELD, MASS.

It is connected with Lake Michigan by the sluggish Calumet River. At the time of building the works the population of Pullman was 4500; at present it is fully double that number. The site of the

SECTION OF A SAND INTERMITTENT FILTRATION AREA.

town is nearly level with a large portion, about seven feet above the lake. As stated by the engineer of the works, Benezette Williams, C. E.: "In the absence of any adequate means of purifying itself, Lake Calumet is wholly unfit for a receptacle for sewage."

LARGE EXPERIMENTAL TANKS, LAWRENCE, MASS.

The sewage-irrigation fields were put in operation in October, 1881, an area sufficient for a population of 10,000 people having been prepared. The works have now been in operation ten years and are said to be successful in so purifying the sewage as to admit of its discharge into Lake Calumet without producing a nuisance; they are also said to be operated at a profit, although definite statements as to both the degree of purification and the degree of commercial success attained are lacking. For winter disposal a portion of the area was under-drained and purification effected by filtering the sewage through the soil. The sewage arrives at the fields in winter with a temperature high enough to insure immunity from serious trouble by freezing. An irrigation farm is also in operation at Cranston, Rhode Island.

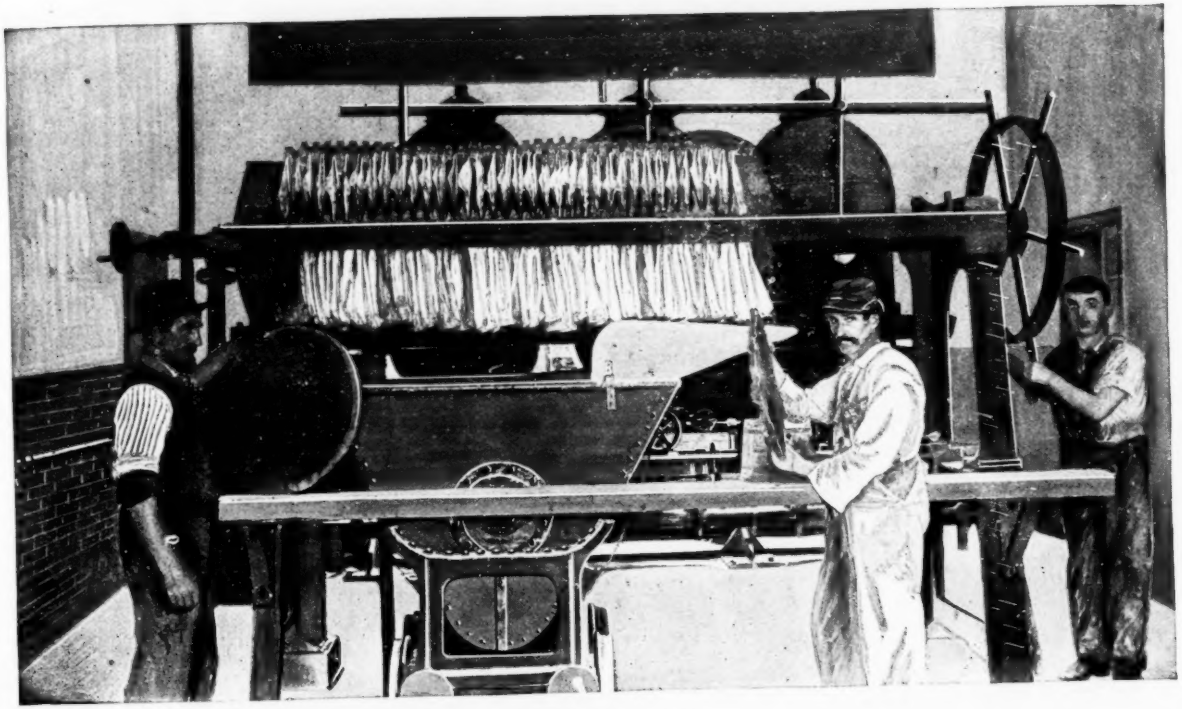
Sub-surface irrigation is a useful modification of broad irrigation in cases where a moderate amount of sewage is to be purified. There are a number of successful examples in this country.

In intermittent filtration usually no attempt is made to utilize the sewage by growing crops. In this system a series of limited areas of land are prepared by leveling, embanking and thorough under-draining to the depth of at least six feet. The crude sew-

age is discharged upon one portion of the prepared areas for a period of from six to twelve hours, though the exact length of the period is not, within limits, a matter of special importance. At the end of the first period the flow is diverted to a second portion of the area, then to the third, and finally to a fourth portion. While the flow is going to the second, third and fourth areas, the first is resting. The second area rests while the flow goes to the third, fourth, and first, and so on. If twelve hours is taken as the length of period of flow to each area, the period of rest is thirty-six hours, and forty-eight hours completes a full sequence. A number of successful examples of intermittent filtration have been in operation in England for about twenty years, while in this country intermittent filtration works have been constructed at Lenox, Medfield and South Framingham in Massachusetts; at Norristown, Pennsylvania, and other places. Combination methods involving intermittent filtration as an integral part of the process are also in use at Morris Plains and East Orange, New Jersey.

The Massachusetts State Board of Health has made intermittent filtration the subject of extended experimentation for the last three years. For this purpose experimental areas were constructed

INTERIOR OF THE STATION AT LAWRENCE, MASS.



A FILTER PRESS IN OPERATION.

at Lawrence and a minute account kept of all the conditions obtaining. The results have been recently published in an octavo volume of about 900 pages. These experiments show that intermittent filtration is not a process of straining at all, but rather a biological process in which the organic matter of sewage is resolved, through the intervention of the bacteria of nitrification, into harmless mineral nitrates and odorless organic nitrogen. This process when rationally conducted differs from the destruction of organic matter by putrefaction in this, that the resolution is accomplished absolutely without the production of bad odors. The objection which has been made to intermittent filtration areas that they smell bad can only be taken as indicating therefore that the areas so objected to have not received rational management. All this and much more is fully elucidated by these recent experiments. They show that in localities where proper material is available intermittent filtration areas may be constructed capable of purifying from 75,000 to 100,000 gallons of sewage per day, so efficiently as to admit of its discharge into a stream used as a public water supply with comparative safety. Chemical and biological analyses of the effluents indicate waters originally purer than that from many wells. The effluents have been repeatedly drunk without ill effects. As a general statement the cost of maintaining intermittent filtration will not exceed, even under somewhat unfavorable conditions, about forty cents per head of population per annum, while frequently it may be expected to fall as low as twenty cents per head and even less.

The intermittent filtration works at Medfield, Massachusetts, constructed in 1887, purify the sewage of a large straw manufacturing establishment, a hotel and a few dwelling houses. The manufacturing waste and sewage of people actually contributing is taken as the equivalent of the sewage of 500 people, pure and simple. The total filtration area of about one acre is divided into four parts, upon each of which the discharge of sewage is alternated in the manner already indicated. The material of this filter area is coarse gravel, and under-draining is found unnecessary. The temperature of the sewage as it arrives at the filtration area is somewhat higher than usual due to the nature of the manufacturing processes, and chemical analyses of the effluent indicate that the winter purification is as satisfactory as the summer. These works were projected by Elliott C. Clarke, C.E., and carried out by Fred. Brooks, C.E., both of Boston. The first cost was about $1000

and the annual maintenance is stated at about $30. They are considered an exceedingly satisfactory illustration, not only of the utility of rational intermittent filtration but of the low cost of maintenance, when properly constructed, $30 per year for 500 people being at the rate of six cents per head of population per annum.

Col. George E. Waring, Jr., has recently carried out a unique modification of intermittent filtration at Wayne, Pennsylvania, where a steep side hill is utilized by allowing the sewage to filter through out broken stone and banks of cinders laid on the contours.

Chemical methods have received a great deal of attention abroad and a number of hundred patents for chemical processes of various sorts and kinds have been issued there. Extended experience, however, has reduced them to three or four, which may under proper conditions be considered as answering the requirements of modern sewage purification. These are treatment with (1) lime; (2) sulphate of alumina; (3) sulphate of iron and (4) by a combination of two of the preceding. The chemical treatments all consist in adding and thorough mixing of the selected chemicals while the sewage is fresh, after which the sewage is run into tanks, where a process of clarification takes place by subsidence.

The supernatant clear fluid is drawn off, leaving the precipitated matter in the form of sludge at the bottom. The sludge may be disposed of either by running on land and burying, or by forming into cakes with a filter press. In this latter form it may be transported to any distance, and in some cases has been successfully utilized as a fertilizer. The best chemical processes remove all the suspended matter and a portion of the dissolved, but we have as yet no reason for supposing that even the most efficient will produce anything like as thorough a purification as may be attained by intermittent filtration. As a general statement the cost per head of population of efficient chemical treatment may be taken at fifty cents per annum. The experiments on chemical purification as made in 1889, by the Massachusetts Board and also detailed in their recent report give, on the assumption that the percentage of albuminoid ammonia removed represents the organic matter, the following amounts of soluble organic matter precipitated in addition to all the suspended matter, the cost of chemicals being the same in each case: *

* As detailed by Rudolph Herring, C. E., in Trans. Am. Soc. C. E., Vol. XXV, p. 147. (Aug. 1891.)

I. Sulphate of alumina at a cost of thirty cents per inhabitant per annum..... 20 per cent.
II. Lime, at a cost of thirty cents per inhabitant per annum..... 22 per cent.
III. Lime and copperas, at a cost of thirty cents per inhabitant per annum..... 29 per cent.
IV. Ferrie sulphate, at cost of thirty cents per inhabitant per annum. 32 per cent.

The best of the results still leaves 68 per cent. of the soluble organic material untouched. In judging of the value of these chemical processes it may be remembered that the price of thirty cents represents the cost of chemicals only. When the expense of attendance, grinding and mixing, and the care of the sludge are added, the annual total cost of fifty cents per inhabitant is quickly reached, as already stated.

A system of chemical purification by the use of lime and sulphate of alumina was put in operation in Worcester, Massachusetts, in 1890. The sewage of Worcester presents some peculiarities by reason of receiving the wastes of a number of manufacturing establishments using large quantities of acids, and only a portion of the total flow of sewage is yet treated. The works, while promising a reasonably successful treatment for the special conditions prevailing, may be said to be still in the experimental state. They were designed and carried out by Charles A. Allen, C. E., City Engineer of Worcester.

At East Orange, New Jersey, the effluent from the sewage-disposal works flows into a stream leading in a distance of four miles to the Passaic River, near the intakes of the Newark and Jersey City water-works. The conditions were therefore such as to clearly necessitate the manufacture of sewage into potable water. The works were put into operation in 1888, and since that time have so satisfactorily purified the sewage of 10,000 people that an analysis of the final effluent indicates water organically somewhat purer than that of the Passaic River itself. The method of treatment adopted is a combination chemical treatment by use of lime and sulphate of alumina, supplemented by intermittent filtration through land. The works were designed by Carroll Ph. Bassett, C. E., of Newark, and are worthy of special mention as being the first large disposal works in this country where the conditions could only be satisfied by converting sewage into potable water. They may be considered as successfully accomplishing such conversion, the cost of which in August, 1891,* is stated by Mr. Bassett at about sixty cents per inhabitant per annum.

* Trans. Am. Soc. C. E., Vol. XXV, p. 156.

The foregoing may be taken as such brief presentation of the present state of the problem of sewage-disposal in the United States as can be made in the space here assigned. A number of disposal works in successful operation are not mentioned at all. A number of large projects are also in the preliminary stages as at Providence, Rhode Island, and Rochester, New York, and in the next few years we may expect to see a great extension of such works in all parts of the country. As a brief résumé of the matter as it stands to-day, we may say:

I. By reason of lack of cheap labor, broad irrigation will not, generally speaking, be adopted in this country.

II. Intermittent filtration is the preferable method where a high degree of purity is required and the conditions admit of its use.

III. Chemical treatment may be used where the object is to merely purify sewage enough to permit its discharge into a stream or other body of water without producing a nuisance.

IV. Chemical treatment alone should never be used where the effluent goes into a stream, pond or lake used as a public water-supply at any point within the influence of the sewage.

V. Combination treatment by chemicals and intermittent filtration may be used when a high degree of purity of effluent is required, but, at greater cost usually than by intermittent filtration alone.

To decide just which method to use in any given case will require the best judgment of a skillful sanitary specialist.

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ALTRUISTIC EFFECTS OF ELECTRIC POWER.

By Frederic A. C. Perrine, D. Sc.

AMONG those who read F. J. Stimson's article in the *Quarterly Journal of Economics* on "John Ruskin as a Political Economist" there were perhaps some who wondered at his closing phrase: "Though the future Political Economy may not be built from him directly, yet it will be rather with Ruskin's earth than with Ricardo's straw that its bricks for building shall be made." Some possibly may have thought that Ruskin's earth was too much in the promised land of imagination for practical brick-making, and few there are, I think, who have thought the bricks to be already a burning. Yet just such brick-making and such burning is to-day the result of our highest refinement in the manufacture and application of machinery. To the economist it may not be apparent, but to the student of Ruskin's works, who is at the same time surrounded by the hopes and aims of the workshop, the result seems most clear.

Many million workmen feel the enslaving powers of the modern methods of production; discuss it, seeking light; and some there are, readers of Ruskin, who feel despair. Others, seeing clearly, feel that Ruskin's best thoughts are being developed in spite of the hindrances. I quote from the London *Electrician*, December 9, 1887:

"A report just published by the Municipality of Geneva on the utilization of the motive power of the Rhone, has attracted some attention in this country by the promise held out of solving one of the most difficult problems of modern industrial life. * * * 'We believe,' say the Municipality, 'that we must endeavor to put cheap motive power within the reach of all, workmen as well as employers, if not as a complete remedy for the prevailing social crisis, at all events as a means of lessening its social dangers, for when power from a central source can be obtained, one part at least of the problem will be solved by the workman becoming his own master.' * * *

"Already by means of turbines and pumps, the Rhone water is distributed, not only in Geneva, but to a considerable number of outlying communities. A great deal of this is used for the supply of mechanical energy in quantities varying from half horse-power to seventy horse-power, working no fewer than 175 motors within a radius of a mile and a quarter from the central station, and many of the motors are in the homes or workshops of the artisans themselves. It is this latter circumstance which affords the municipality the greatest satisfaction, the report stating

hat the success of the scheme is due to the fact that the power has been carried to the worker instead of requiring him to come to the power, or, in other words, to aggregate the workers into a few large factories, with all the evil consequences, moral and physical which attend the factory life. * * * And the Council have under their consideration the expediency of introducing electrical transmission in conjunction with the hydraulic power hitherto employed."

It seems strange indeed if, where the introduction of power enslaves, its higher application should emancipate, and if Ruskin's antipathy to machinery should be dispelled by the introduction of its higher refinements.

In the Genevan experiment and those of a similar character it only remains for the introduction of electricity with its greater susceptibility of subdivision to carry the beneficent effect still further in the same direction, and as we see springing up around us on every side electric stations capable of distributing in the minutest quantities thousands of horse-power, we begin to see the possibility of the re-introduction of the home manufacture, the individual workman throwing his soul and his genius into his work, and the man rising above the necessity of combination for fighting purposes.

One of the first expressions that was given to the hope that this might be the effect of the electrical distribution of power, was in an address before the International Congress of Electricians at Paris in 1881, when M. Louis Denayrouse earned the plaudits of the assembly by the assertion that the introduction of electricity would tend to elevate the worker's position, and to destroy the great slave-dens of factories. Falling, as it did, upon the ears of many friends of St. Simon—they were the first to light the streets of Paris with electricity—the thought has been developed, till to-day you will hardly find a man of electrical science without a picture in his mind of a world rehabilitated through its agency.

Wherever you meet the application of this new and subtile form of energy you will see a revolution in methods and a change in processes always tending to greater healthfulness of operation and ease of work. The smith, moisty and covered with grime, noisily welding a bar of metal, is to-day excelled by the great electric machine, internally heating the bar and forcing its ends together by hydraulic pressure so easily that a woman might control its wonderful energies.

In place of the copper-smelting furnace, devastating by it noisome gases the country for miles around, the electrolytic bath produces a purer product quietly day and night, and so cleanly

that the Elmore factory in England, where are produced wonderfully strong and homogeneous tubes of copper directly from the ore without smelting, casting or drawing, is described as decorated with bright flowers growing freely in its gardens and window-seats.

The processes of electro-bleaching introduced during the last two years, whereby the same solution becomes over and over again a powerful bleaching agent through the energies of the electric current, are enabling us to obtain paper and linen as white as snow with no contamination of our streams by refuse bleaching powder, while Prof. Lodge is teaching that a slight discharge of electricity in a soot-laden atmosphere will cause it to fall, and render at least some of our chimneys inoffensive. So we have moved till we seem to see the time when Ruskin himself, lover of chemical processes as he is, could not ask a nearer approach to his ideal of a workshop. With our powers consolidated and operations cleansed we may again take joy in the streams and breezes of England.

But Ruskin's central idea is not at all the clearing the sunbeams from smoke and the restoration of a beautiful England, not even yet the destruction of the economic man of the workshop, but rather he would see the end of the unthinking and illogical man. To him a man must live as he believes; he must not be a Sunday moralist and a week-day robber; but as he believes, so must he live, and it is as extinguishing this necessity in mass action that he curses the workshop and its cause, steam.

The theory of the factory is that of the division of labor between the man and his machine, as well as between man and man, but the extreme of subdivision may coexist with production on a comparatively minute scale and without loss of individuality. Its cause is the very natural and healthy desire for greater individual efficiency, while its effect is an increased man-supporting power of the world. On the other hand, production on a large scale is of benefit mainly to the capitalist who can make a dividend on a million and not on a hundred thousand; its means are great factories, and its effects are the loss of individuality of the worker and his consequent loss of interest in his work which is turned off in the easiest possible manner, the overcrowding in factories and tenements, and in increased profits to the millionaire.

All this is a matter of congratulation to the orthodox economist. He would see much goods stored up for many years, and his aim of teaching has been to explain away and aid in the subjugation of strikes and strikers. Ruskin has dared to say: "Your strike is a

product of evil moral conditions in which you are concerned for a true political economy." He says: "How can you expect white lives, quiet lives, where you keep the people making noise and grime, never stopping to clean, even the streams breeding disease in their midst?"

He fails to consider but one thing, and that, that we machinists are so painfully young and have not yet ceased our astonishment at our own growth and size. The scar made by our first spade-thrust is not yet healed, and even active busy nature has not yet had time to cover even as a scar the first railroad cut. Hardly a factory can boast a hundred years of life. Can we then be surprised that it seems as we pass through it, nothing more than a temporary structure for to-day and not for to-morrow? With Watt dreaming over his mother's tea-kettle was inaugurated a new era of life, and a new people were formed, a people unknown to the French revolution, slaves truly as Ruskin sees them, but slaves emancipating themselves as never did slaves before through the very development of their means of slavery.

For bare existence and warmth, the people must mar their hillsides or forests and sully the fairest streams and valleys with home fires and smith fires, but smoke, that curse of England, we are banishing as we develop our natural and artificial gas, and while we see many a fair field devastated for gain, it is but the rudest manufactures that are there introduced; we are beginning to learn in the older countries that something must be given for peace and comfort, that Ruskin has found the fallacy, that we have not lived, have only made progress. So are the bricks from Ruskin's earth to be made; it is truly impossible, should we wish it, to blot out the past hundred years; the machinery is a fact never to be forgotten or destroyed. If there is to be aid for man, it is to be through it and not in spite of it. It must not be that it gives the possibility only of a useless idleness, but as the years go on and bring their further development, it must bring strength to the weak and aid to the down-trodden. So we see it in its highest and latest advancement; had Ruskin the power to see, and the faith to believe the frantic illness for a life's work unheeded might have been spared him. His way is surely not the world's way, but the goal is one, and where he has called, "halt," the halt is coming; art must live purer, and man purer, better and happier as he becomes more intelligent, discovers more wonderful machines, and learns to live not alone for himself, but for his weaker brother in the lessening struggle.

TYPE-SETTING BY MACHINERY.

By Walter E. Crane, M. E.

IN no other art, perhaps, has so little progress been made during the past four centuries as in that of type-setting since the days of Gutenberg. In all other work connected with printing there has been great advancement, the cylinder-press and stereotyping, for example, having revolutionized their respective branches of the art. Not until recently, however, have any attempts of note been made to avoid the tedious work of picking up each separate type from a chaotic heap in its allotted apartment in the "case," carefully turning it right end up and right side foremost and placing it in line in the "composing-stick." It may seem surprising that this work, so important in its results, should have remained in a crude stage throughout the period of the world's history marked by the greatest achievements of inventive genius. It is a hard problem to solve to be sure, with an exacting set of conditions to meet—delicate operations to be performed quickly, automatic adjustments to be made and a changing of vocation of an army of workers trained in the "old way." But is it too much for the indomitable will, pluck and everlasting energy of our trained inventors? They claim that it is not; that they have overcome other tasks equally difficult, and that they are now in a position to promise positively all that the printer asks in this line. It is significant, to say the least, that within a few weeks a contest between four type-setting machines, continuing through six days, under the most exacting requirements, has been held in Chicago under the auspices of the American Newspaper Publishers' Association, and that the manufacturers of these machines have since received numerous orders from newspaper offices. Already several important daily journals in this country, and a few in England, are set up without the aid of "compositors." The Typographical Union, it is understood, now regards the coming of the type-setting machine as inevitable.

The actual setting of type by machinery is not a new thing. The arrangement of the type in lines, properly spaced, has required some manual work, however, with the result that the machine afforded no economy in newspaper printing. Of late this manual assistance has been so minimized as to wholly remove the objections

from many minds, and the most distinguished printer in this country is at the head of a company formed to manufacture a machine which took partin the Chicago contest. Standard type is used, and the result, as shown in the printed page, is the same as that from type set by hand. The machines of this class automatically distribute the type after it has been used in printing. The type-machine inventors are not content to stop here, however, but insist upon producing a device which shall not only dispense with hand-work in "justifying" the lines, but also with the use of types as that word is now understood. The problem is to produce, from a pot of molten type-metal, the equivalent of lines or columns of printing-type, the whole to be done by machinery. What is aimed at is rather a "matrix machine" than a type-setter, since its purpose is to cast letters, or lines of type—not to set types bought from the foundry. With one exception the machines competing at Chicago were of this class.

Let us look for a moment at what is demanded in the invention of a matrix type-machine. There is the selection and assemblage of the desired types into a compact line, the justifying or even spacing out of these types to fill the line exactly, the taking of a copy of that line in a form that can be used in printing, and the distribution of the types to their former places when the metallic copy has been taken.

It is at once obvious to the trained inventor and the layman alike that in all probability the best way to do this is by touching keys similar to those of a type-writer. The reproduction of written intelligence by touching a key for every character, or letter, has been proved a complete success, at one-half or one-third the speed of the ordinary thinker; there are already many thousand adepts at key-manipulation, and thousands of type-setters are already familiar with all the requirements and could learn easily to manipulate key-boards at several times the speed of setting type by hand. But there is more to be done and it is much more difficult than type-writing. Aside from the ordinary 26 capitals and 26 small letters, 10 figures and 9 fractions, there are punctuation points and "double letters," making something like 108 or 110 characters, of six or seven different widths, to be produced in ordinary printing.

Three distinct methods of getting at this problem have been opened up thus far, by the invention of machines as follows:

First, the Single-Die class of machine, in which each character or type is taken, impressed in papier-maché and returned to its

place before the key is struck or the machine placed in position for the next character. By pouring molten type-metal into these impressions, which is done automatically, type-faces are formed for printing. The Electro-Matrix machine is, or was, a sample of this class.

Second, the Magazine class, having a magazine, or receptacle, for each of the 100 or more letters in the "font" used. In the respective magazines are placed about as many types or characters as are liable ever to be used in one line, say 15 a's, 15 i's, 10 m's, 3 x's and so on. The types used are matrices, into which, after a line has been assembled and justified, type-metal is poured, forming a solid line for printing. The Mergenthaler "Linotype" and the Rogers "Typograph" are specimens of this class.

Third, the Multi-Font class, in which there are as many complete fonts or complete sets of type as there are liable to be letters in a line, there being any one of the first complete font at hand to select from for the first character in the line, any one of the second font for the second character, and so on.

It undoubtedly is a very difficult matter to obtain really good results from the single-die class of machines, for the reason that from the dies being impressed one at a time into papier-maché, it is not easy to get a uniform depth of impression, particularly as the operation must be performed very quickly. There is extreme liability, in making each impression, of disturbing the preceding indentation, so that when the type-metal is poured in it will fail to reproduce some of the letters. Thousands of different substances have been experimented with in which to make impressions, but paper having one surface slightly pulpy, and the other firm and solid for a backing, with a mucilaginous substance between, seems to be about the only satisfactory material for this class of work.

The simplicity of the single-die class is its chief point of superiority. Its speed, however, is at the opposite extreme. A prime obstacle to speed is the justification or spacing. The nearest to a successful machine in this class which I have seen required that the "copy" to be set should first be produced upon a type-writer having a recording division, showing the sum of units of width of the characters selected, and this number was recorded at the end of the line, to be used as a copy-sheet for the operator of the matrix machine. In order to distribute the characters properly through the lines, it is not only necessary to touch keys twice for the matter, but a mental tax is imposed upon the operator to properly justify it.

Not much can be said for the convenience of the single-die class, for the best of this class have been one-key machines, instead of those giving use to the fingers of both hands. The space occupied is about the size of an ordinary type-writer table. The cost is not much lower than other classes, since it is necessary to provide them with perfectly-cut hardened-steel dies, whereas the other machines can use cheap dies or matrices, which are punched or pressed. I know of possible remedies for some of the defects in this class, notably in justification, which will make themselves known in due time, but the "coming machine" does not seem just at present to belong to this class.

The Magazine matrix machines have been brought to a higher degree of development and more has been done with them. More than 200 such machines are said to be in use in newspaper offices to-day. The two leading examples are the "Linotype," invented by Ottman Mergenthaler and James O. Clephane, and the "Typograph," patented by John R. Rogers, of Loraine, Ohio. The first patent on the former was issued March 17, 1874, while the latter dates only from 1888. The product of these two machines is essentially the same, namely: The line of type cast against the assembled female dies or matrices.

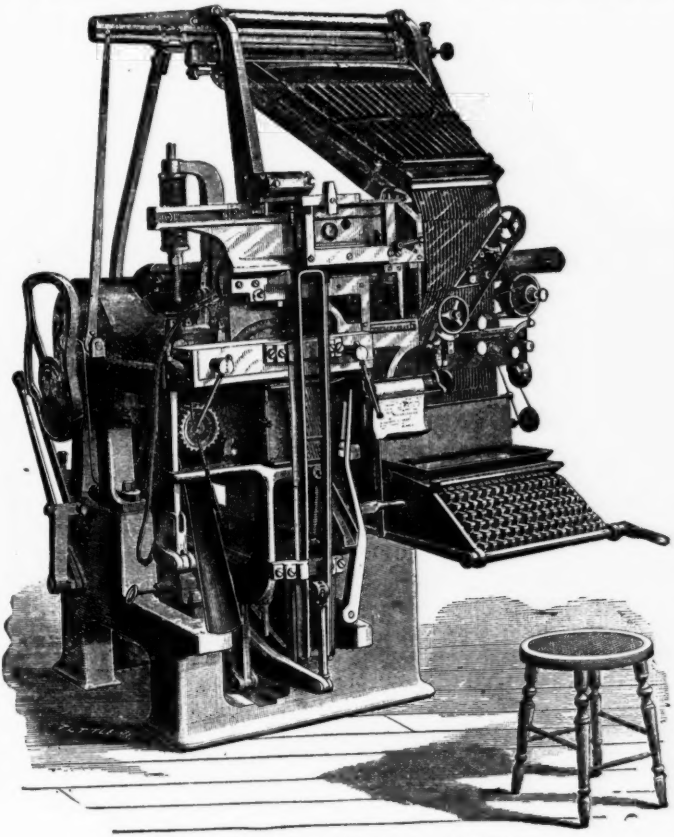
The Linotype, instead of movable types, uses movable matrices of brass—one for each letter and punctuation point—which are placed automatically to form a line of matrices, by which a solid line of type is cast. When a letter on the keyboard is depressed it permits the corresponding matrix to drop from the particular magazine which contains a number of similar matrices and takes its proper position in the line formed in a holder on the left of the machine. A mark cut into the holder designates the full length of the line of type which the machine is gaged to make. When the operator sees that the line is complete he presses a lever and the assembled line of matrices and spaces is transferred to the face of the mold.

Sometimes the line is not quite long enough, and yet there is not room for another word or syllable; then the ingenious devices used to separate words come into play. As the line of matrices moves toward the face of the mold the steel wedges inserted between the words are pushed up and thus spread the matrices enough to make a full line.

Connected with the mold is the pot of type-metal, kept in fluid condition by a Bunsen gas-burner. When the matrix for a line of

type is in position the molten metal is fed automatically against its face, filling the mold, where it solidifies and becomes a linotype bar bearing on its edge in relief the characters corresponding to the line of matrices. An automatic stripping device withdraws the linotype bar, which is then placed automatically and trimmed to the right proportions and ejected upon the pile of linotypes previously made.

While all this is going on another automatic device lifts the line of matrices to the top of the machine, where it is made to



SPECIMEN OF TYPE-SETTING MACHINE—THE LINOTYPE.

travel back over the row of magazines. Each matrix drops into the tube in which it belongs, ready to be used again. As soon as one line of matrices has been set the operator at the key-board begins upon another line, the processes of molding and distributing proceeding without manual assistance.

Summing up the Linotype machine I would say that the quality of its work is fairly good; it is lacking in simplicity of construction; it would be capable of great speed but for its liability to make transpositions of letters, and its complications to the extent of taking the attention of the operator from his legitimate duties. It is a convenient machine, considering its size, the floor-space occupied being four or five feet square and the height six or seven feet. Its cost is excessive, being about $3500 to $4000. The cost of gas to keep the melting-pot going is a considerable item, as also the cost of expert attention, repairs and delays. The whole machine seems to fail to arouse the enthusiasm of the printer, for these reasons. It is fair to say that it is used, however, by such journals as the New York *Tribune*, Chicago *News* and Louisville *Courier-Journal*.

The Typograph, though of the magazine class, does not really use magazines, but substitutes for them wires upon which the types, or dies, are strung. As in the Linotype, upon a key being struck, the corresponding type is released by an escapement, and allowed to slide down an incline and pack down again those previously selected, until the line is full, when a foot-lever is pressed, starting the automatic machinery which simultaneously expands the spaces, then clamps the type, closes the mold against them, makes the casting, opens the mold when cool enough to "set," unclamps the type, whereupon the operator tips up the frame containing the wires, when the type slide back to place behind the escapements. Then the frame is lowered and the setting proceeded with for the next line.

The quality of work of the Typograph is about the same as shown by the Linotype. It has the advantage on the score of simplicity. Speed is a point not so well achieved; there are more movements to be made with hand and foot, and the types are apt to become interlaced on account of their length. Objection has been made to the necessity for operators to stand while at work, and to the unpleasant proximity of the melting-pot. The demand for space is more moderate. In respect to its patents the Typograph seems badly off. The Linotype having been so long a time in the

same field and class, naturally has occupied enough of the ground to make an endless source of trouble, if not to stop it altogether.

The Multi-Font class is represented, so far, by the Typo machine, manufactured by the Johnson-Crane Matrix Company, of Minneapolis. It differs from other machines in that it only records the selection of a type when the key-board is struck, and the types do not actually come to place until the letters have been designated for a whole line. They are then assembled simultaneously. While they are coming together that which in the designating mechanism answers to the carriage of a type-writer returns to its place, when the touching of keys may be proceeded with for the next line. Meanwhile the automatic movements are performing every function in using and returning to place the line first designated. When keys have been touched for a line, and another syllable cannot be put in, a special key in the key-board called the "starting-key" is touched, and simultaneously the justification is done automatically by a process entirely unlike that of other machines. The product of the machine is either lines of type, as in the Linotype or Typograph, or a column matrix. The machine may be built with female dies, for the former product, or with male dies and impressing device, for the latter. An important feature in the construction of this machine is that the types never lose connection with their home-place, though they have all the liberty of perfectly independent movement in their assemblage into the line, without any possibility of interference. Regarding the feature of the type losing all connection with their home-place, as in most styles of machine, one has aptly said: "It is an ingenious embodiment of the wrong idea." Undoubtedly it will be found that the maximum of convenience and accuracy will be attained in the perfection of the idea of having the types operated about a common center, that they may be operated and controlled by similar mechanism from the same source.

The Typo is the smallest of the matrix-machines. The space is usually about twenty by thirty-two inches, and thirty-six inches high. Without a table it will occupy less space. The cost is moderate, the simplicity remarkable, and the speed limited apparently only by the ability of the operator to strike the keys. Being no longer connected in any way with the development of this machine, I may say that I myself designed, constructed and tested such setting mechanism for it as worked perfectly at the rate of more than 2400 key-touches per minute.

Still another form of machine attracting attention lately is the Lanston, which casts separate types, sets and spaces them automatically, guided by perforations in a roll of paper made by operating a key-board. Each perforation corresponds with a particular letter, point or space.

In regard to the product of all the matrix-machines, there seems to be an extraordinarily strong demand for a kind of product that I do not believe is the best one for the public or for the printer. The public should demand, clear, sharp, clean-cut printing from whatever machine is used. Their eyes are at stake. It is an indisputable fact that the more times copies are taken between the "matrix-machine type" and the stereotype used on the press, the more faults and imperfections will there be developed; consequently indistinctness, irregularity of impression and ragged-edged faces will the more characterize the work.

I take the stand, though ninety-nine out of a hundred printers will be against me until my ideas are successfully carried out, that the matrix-machine should be equipped with male dies; these should be impressed, a line at a time, into a suitable material, as papier-maché, making a column matrix. These column matrices for a page should then be put into a curved form, and the stereotype made from them that goes on the cylinder press and from which the newspaper is printed. Thus, the printing is done from the second copy from the type, the same as if the type were set by hand.

Now a word about the necessary change of occupation of some of the type-setters, which is sure to be brought about by the successful matrix-machine. Not so many will be thrown out of work as might be supposed. The introduction of the machines will tend to double or treble the printing business, because it will make it cheaper. Consequently there will be more stereotyping, more press-work and more book-binding. I sincerely doubt that there will be much of a reduction in type-setting, and these trades, and more likely a gain when paper-making, handling and selling the product are all considered. My advice to the good type-setter would be to spend an hour each day this winter in becoming proficient on a key-board; it may save him from getting promoted (?) to the press-room or stereotyping department.

THE NEWER FORMS OF FUEL.

By Hosea Paul.

THERE are many ways in which a civilized society may be distinguished from a barbarous one, but in none more clearly than in the use of fuel. Primitive man had to be content with heat as nature gave it to him—from the direct rays of the sun. We know, however, that the sun's power in yielding heat is not merely what we feel, but that we may trace it to remote effects ; it is found not only in the growing life around us but in the changing and decaying forms of the past, as in the coal-beds. It is only recently that we have learned that matter is indestructible ; still later of the correlation of energies. It is something to realize that the sun has not shed any of its beams in vain, but that the mighty flood of light and heat that has been poured upon the world from its beginning has been stored up for man's use. The discovery and utilization of these fruits of past expenditure has become one of the most potent factors of human progress.

Civilized man having gained the power of commanding heat and of devoting it to myriad uses for his pleasure or profit, it becomes a leading question how to produce it with the slightest exertion, or how to obtain the fullest results from its application. Up to the present one might have taken a piece of coal as a type or synonym of heat and force. This illustration has its limitations, however, in that matter does not always present the same form or appearance. We need to speak of coal in its concrete and familiar form only to call attention to its analogy to the liquid and gaseous forms. The process of combustion, by which its energy is released, is not a destruction of matter but a change or conversion. The solid, in great part, assumes the gaseous state. A lump of coal, then, is simply raw material out of which gas may be made. If placed in a furnace to be burned the process is two-fold : first to separate the gases from inert matter, and secondly to consume them, thus producing heat. Whether it is more desirable from the standpoint of economy to carry on these processes separately is a question to be considered.

It is well known how small a percentage of the heat units shown by chemical analysis are really effective in yielding results. The

smoke nuisance, so much complained of in modern city life, is an example of imperfect combustion, the problem being not to consume the black flakes of impalpable powder which constitute the offensiveness of smoke, but to prevent their formation, by more complete and perfect combustion. As coal is so largely resolved into the gaseous form before actual combustion, much attention is being paid to making the production of such gas a separate and organized effort, instead of leaving it to chance and accident.

The idea of using specially-produced gas for heating was a natural outgrowth of its use for lighting purposes. The method of its manufacture, however, is different. Illuminating gas undergoes processes of preparation, enrichment and purification which, while they increase its cost, are not intended to increase its heating properties; such as remain are merely incidental. Only such vapors are driven out of the coal as are useful for lighting. When the process of evaporation and distillation is complete a large part of the original material, the coke, remains, which is specially valuable for heating. Another important consideration is the comparatively small scale in which illuminating gas is made, and the well-known fact that the price paid by the consumer is not limited to the actual cost of the gas, but to the relatively large cost of organization, distribution, and collection of bills.

It is only a few years since public attention was called to the immense waste of gas in coke-making. The coal is roasted in ovens and only the solid product saved; the gas evolved, which is great in quantity, and similar to illuminating gas in its initial stages, is allowed to waste. So great is this waste at Connellsville, Pa., that it has been proposed seriously to convert it to useful purposes, a project which has been postponed only because of such an abundance of coal that commercial needs have not demanded the closest economy. Such waste is strangely unworthy of the age and reminds us that in spite of boasted advancement we are still barbarian in some things.

The production of gas for heating is of comparatively recent date; its processes are incomplete, and the subject far from a finished one, though it has been the subject of upwards of a thousand patents. One need only to visit rolling-mills, furnaces and kilns in different parts of the country to learn that fuel-gas, or as it is generally called, "producer-gas," is already an important and rapidly-increasing factor in metallurgy, pottery, glass-making and kindred industrial operations. For steam-making, for instance, the

kind of fuel is mainly a question of economy, but for metallurgy and the ceramic arts much more is involved. It is the question of the maintenance of the regulation of the supply, and its ready control, of freedom from smoke particles, injurious gases and the by-products of combustion. The use of producer-gas thus enlarges possibilities and leads to the building up of new arts.

The problem that presents itself in making producer-gas is to make available as large a proportion as possible of the heat-units contained in the coal. To do this successfully considerable range is required in the kinds of coal, using as nearly as may be the quality found in each locality, in order to save the cost of transporting any particular grade from place to place. There must be, moreover, a means of preparing and adapting gas to particular and specific uses; for instance, different kinds may be used successively for metallurgy, for kilns, for steam-making, for heating dwellings and for cooking food. An important practical point is that it shall have by nature or by special device such a strong and characteristic, if not offensive, odor that leakage will at once attract attention.

It is significant of the future of manufactured fuel-gas that the subject should have received so much expert attention in the city of Pittsburgh in competition with the abundant natural product. It is asserted that gas can be made at a cost of two cents per thousand feet, and that a plant for the manufacture of one million feet per day will cost less than one-fifth as much as an illuminating-gas plant of similar capacity. It is likewise stated that the working force required for such a plant is only three men and two boys continuously employed. Still quoting from the claims of the projectors of a gas-making process, it is said that the quantity of gas that it is possible to produce from a given quantity of coal, depends upon the quality of gas desired. Of that variety best adapted for metallurgy the bulk is nearly double that made specially for household uses.

Now if any such claims can be even approached this will make a very cheap and a very convenient fuel. Such cheapness would be possible mainly from turning to account a much larger percentage of heat units than has ever been done before. But because this has not yet been done, or because some statements are a little premature, if not extravagant, it cannot be denied that a great harvest awaits the careful gleaner in this extensive field.

The use of liquid fuel is of very recent date, and confined

mainly to crude petroleum. This has long been recognized as a possibility, but was delayed because of the comparatively high price of oil. In 1865 the price was $12 per barrel, but by 1882 it had declined to fifty cents. Up to this time its production was limited to a comparatively small area in Pennsylvania. But the area in which it may be found has widened and in spite of attempts to enhance prices by curtailment of production the supply is so great and comes from so many sources that it is not likely to advance in price materially for many years.

So far as illuminating oil was concerned, few would venture to assert that the world's needs were not already supplied when an immense outfield was developed at Findlay and Lima, in Ohio. In 1885 the existence of such a field was wholly unsuspected, but within two years there was a daily production of more than 20,000 barrels per day. It could not be said that it was needed as an illuminant; it had, moreover, a disagreeable odor not easily removed by the ordinary refining processes. Barred out as an illuminant, manufacturers were sought to try it for fuel, and it rapidly came into extensive use. It did not require any preparation or purification, nor any expensive apparatus. Its use was then mainly a question of price and heating efficiency. As to the latter many scientific and practical tests were made. One made at the North Chicago Rolling Mills, in the summer of 1887, consisted of burning different kinds of fuel under the boilers used in generating steam in their extensive works and noting the quantity of water evaporated in each instance. The result was that for each pound of Indiana block coal consumed 7.4 pounds of water was evaporated, while a pound of Findlay crude petroleum evaporated 15.2 pounds. Similar results have been attained in many other instances, and their possibility can be shown by chemical analysis. A barrel of oil contains from 260 to 300 pounds, or about seven barrels to the ton, but because its heating value is twice as great we may set down 3½ barrels of oil as equivalent to a ton of coal.

In considering the problem of fuel supply the question and cost of transportation is important. The fuel supply of Boston is derived from Pennsylvania, not less than 300 miles; that of New York, perhaps 150 miles; Philadelphia somewhat less than 100 miles, and Cincinnati and Chicago from points from 100 to 200 miles. The cost of transporting petroleum in bulk in tank cars does not greatly differ from that of coal because of the unavailability of the tank cars for return loads. If the price paid for trans-

portation is three-fourths of a cent per ton per mile, it will cost about 11 cents to haul a barrel 100 miles. If oil can be bought at Lima or Findlay for 30 cents, its net cost at a point a hundred miles distant is 41 cents per barrel, at which price it can compete with coal at $1.44 per ton. At a distance of 300 miles it will cost 63 cents per barrel and compete with coal at $2.21 per ton. The cost of carrying coal is not likely soon to be greatly reduced, while the problem of oil transportation is capable of immense development. When the great oil wells were struck at Pithole, in 1865, the entire yield was drawn off into barrels and hauled in wagons over rough roads to the railroad station at Titusville at a cost for hauling, at one time, of $2.50 per barrel. Now oil is transported to the most distant parts of the world and barring, the artificial restraints of tariffs, sold for less than this. This is mainly possible because of pipe-lines. Compared with these in efficiency the tank car is half way back to the Pithole mule-team.

This changes the whole situation and makes it possible to transport oil from Ohio to Chicago, or to the sea-board, at a trifling cost. Before the close of 1888 the northwestern Ohio oil-field, without any extended pipe-line, was displacing 2000 tons of coal per day.

One need but visit this great oil-field, see the immense quantities of oil stored in tanks, see how little of the area has yet been developed, then think of how many new sources of supply are possible to realize that oil fuel is bound to have a great career.

The third form in which nature provides our fuel is that of gas. Natural gas is as old as history. The Chinese cannot remember being without it. It has issued from the shores of the Caspian since the days of Herodotus. It is the dread "fire-damp" of the English mines, the "marsh gas" that threatens the well-digger the world over. But its special development in immense quantities, its transportation and distribution as a factor in domestic and industrial economy, are facts so recent and so rapid that only specialists are aware of its extent or importance. Its use in this way has been developed almost entirely since 1880, and is almost altogether an incident of the development of petroleum production.

In drilling for oil it always has been common to strike veins of gas. About 1867 it began to be used for fuel under the boilers that furnished the steam to run the drills and pumps at the oil-wells. Wells were struck which yielded such volumes of gas that far-seeing men began to concern themselves to find new uses for

such an abundant and spontaneous product, especially near the borders of the city of Pittsburgh. Here, of all places in the world, was the most fortunate one to try on a large scale the experiment of its use. This great city was built up by its furnaces, its rolling-mills and its glass-works, all made possible by the surrounding hills filled with coal and iron. The name of Pittsburgh became associated with the abundance of its fuel and with the cheapness with which it could be delivered at the furnace door. Over it hung a pall of grimy smoke, as from a seething hell, darkening the sky, penetrating every crevice and leaving its sooty deposit on every object. The city was a bustling hive of busy, blackened toilers.

But signs were not wanting that, as the center of the iron industry changed, its supremacy might depart. Among the fastnesses of the southern mountains great deposits of coal and iron were found and men began to develop them, and already a great tide of speculation and investment was turning thither. The new conditions following the use of natural gas turned the scale and Pittsburgh was saved. Her great industries sprang almost at a bound into such power and consequence that competition was shut out of sight for years to come. The use of gas fuel soon became general throughout the whole oil region of Pennsylvania and West Virginia. The sun again shone and brightened the valleys once obscured by smoke, and soot and grime were only a memory of the past.

Outside of the Western Pennsylvania and the West Virginia fields the most noteworthy development is in northwestern Ohio and eastern Indiana. Not until Illinois and Iowa had become great states, and the homesteader was implanted on the sunny plains of Kansas and Nebraska, was this great territory fully reclaimed. A little more than a generation ago it was much of a wilderness. Now fully reclaimed, it is the very type of a rich and fertile region, and health and thrift is the farmer's portion. But the growth of towns was plainly limited. There was neither iron nor coal, the water-power was feeble, and manufacturing on any large scale seemed impossible. To all places time brings changes, but to this furrowed region it came with startling suddenness. Here in 1886 was found almost by accident, almost in defiance of the teachings of scientists, deep in the underlying rock, a precious vapor distilled in nature's alembic, no less potent and powerful in human weal than the fluid first found among the wild hills of Pennsylvania and which has since served to light palace and hovel, that has followed traffic all over the world, that has driven the whale ships from the seas.

The first discovery and utilization of this gas was at Findlay. Discovery progressed until that town now boasts of the most famous, though by no means the largest, gas-well in the world. Its yield has been stated by Prof. Edward Orton, of the Ohio Geological Survey, at 12,000,000 cubic feet of gas every twenty-fours, equivalent in heating power to 480 tons of bituminous coal.

As soon as the first shock of surprise was over the citizens of Findlay began to think of making use of the blazing streams of fire so freely poured forth. Men saw and marveled, then set to work; glass-makers in particular resorted here and established their factories, and other branches of manufacture were quickly established. Within a year the quiet old-fashioned interior county-seat had became a busy home of workers. Buildings, factories, dwellings and stores sprung up and multiplied. Early in 1887 the leaven of progress was working, and as the chill airs of winter began to give way to the balmy airs of spring strange faces began to be seen on the streets. That peculiarly western institution, a "boom," had struck the little city. The fire of speculation once kindled, it spread like a prairie fire to every other locality where gas might be found. As for the "boom" itself, it soon spent its force; the rapid marking up of values of lands and lots soon outran and passed beyond reality. Yet Findlay grew in population in three years nearly fourfold. The discovery of gas at Findlay was followed quickly by successful developments in Indiana, and the rapid growth witnessed at Findlay was repeated in many towns. In these towns there has been much careless and inexcusable waste. The gas has been allowed to escape freely. It has been used to light streets with flambeaus, and allowed to burn all day because it was a little trouble to shut them off. At Findlay householders used it without stint, paying for a time only fifteen cents per month for each stove. Manufacturers were invited to come and establish themselves, use as much gas as they liked without charge or control, leaving the land-owners to recoup themselves by the increased sale of lots required for the factories.

But the limitations of the gas field were soon discovered. All told, the Ohio field would scarcely cover more than 2 or 3 per cent. of the area of the State, and of this a large portion was soon acquired by one of the branches of that modern marvel of wealth and power, the Standard Oil Company. It knew the value of gas, and proposed to sell it—not waste or fritter it away in idle display. It built pipe lines to Toledo, Tiffin, Fostoria, Lima, Fremont, Norwalk,

Dayton and even to Detroit, but soon found out it could not afford to give it away to manufacturers in competition with town-site syndicates, and especially when there was an endless and profitable demand for domestic use. Then there was a well-grounded fear that gas-wells were a temporary phenomenon; that the yield would gradually diminish and finally cease. The cry went abroad that natural gas was giving out. The rates for the supply of fuel to factories were at first merely nominal at Pittsburgh, but they have been raised until the use of coal has been largely resumed by manufacturers. The same tendency is plainly observable in the Ohio fields, and that it will soon appear in Indiana is beyond question.

As to the actual amount of gas produced it is difficult to obtain exact figures; too many people are interested in concealing or misstating the facts. But one tendency cannot be overlooked—the gradual withdrawal of gas for other uses than domestic heating and cooking. The demand from this source alone is already equal to the supply, especially if conservative notions prevail in regard to its permanence. Such use permits of better prices than to maintain factories, built to sell town lots, and that those who have monopolized the visible sources of supply should seek to restrict its uses to the more profitable channels is not to be wondered at. Nor is it strange if, in order to get the business into their own hands, men should "bear" the market by working on people's fears as to the permanence of the supply. The truth lies doubtless between the two extremes. The better opinion is that there is enough for legitimate uses, and that it will still be found in new regions.

For nearly three years the territory from which natural gas has been drawn has not been sensibly enlarged, and except in the new fields its general use for manufacturing has steadily diminished. There certainly need be no fears that coal-mining will become a lost art. But we are inclined to think that the present tendency is mainly a halt or reaction, and that natural gas has come to stay. Just now its uses are merely suggestive of the future. It brings to us fuel in the most convenient form—the refined essence freed from dross, weight, impurity; self-transporting, smokeless, an invisible potent agent that once possessed of we cannot well part with. If nature cannot be depended upon to furnish it ready made we must undertake to make it, or something nearly identical, out of coal or oil.

We have to glance backward only a few ages to find a time when the limited manufacturing power of the world was little else

than unaided human muscle. The loom of the house-wife, the forge of the smith and the potter's wheel were almost the only examples of the indirect application of human strength. Almost the first to get relief from useless toil was the woman grinding at the mill and the galley slave of the war-ship. For them the wind was made to turn the wheel and force the sail, and these ancient tasks are forgotten ones. On the low plains of Holland, on dreary Spanish wastes, on wide Americans plains, the wind-mill is still swinging its vast arms that grind the corn and lift the welcome water. But the wind that "blows where it listeth" is too capricious for many of our modern uses, and as the need of greater power and steadiness became apparent a new force, that of the flowing rivers was harnessed to our service. The water-wheel was vastly better than the wind-mill, and men sought out sites for cities by the side of swift streams. Here in America grew Lowell, Lawrence and Holyoke, Paterson and Rochester, and later still the modern marvel Minneapolis. Up to within the memory of even young men the supremacy of water power seemed complete and undisturbed. But the steam engine was being perfected, year by year, until at last, in broad plain, by lake and sea and quiet river, far from cataract or rushing flood, great wheels were turned by a force that rivaled that of the winds, or that of the gravitation of water—by the still mightier force of steam and coal.

It is still the age of steam and coal, but is this to be the type of all future time? Electricity is already with us and there are indications too plain to be disregarded that the coal fire is to remain under special conditions only, just as the wind-mill and the water-wheel retain a place in the world's economy. Who then can say that the age of gas is not yet to come?

When we consider that of all the products of the mine coal has been reckoned the most important; when we remember that the Lehigh and Lackawanna coal fields alone have created fortunes more vast than the gold mines of California; when we realize that it has revolutionized the means of locomotion, that it has opened new highways of trade and travel, that it has supplanted the water-wheel on land and the sailing ship on the seas; that it is the impelling force of commerce, and the foundation of a manufacturing system that has developed into proportions that were undreamed of a generation ago, what shall we say of the future, with the possible, yes, probable displacement of coal by something vastly better?

As the world moves, and as surely as the sailing vessel replaced the galley, as the swift locomotive took the place of the post-horse and stage-coach, as the trained lightning displaced the courier, so will coal, cumbrous, costly and grimy, give place to some more perfect, more ethereal essence, evolved from itself, distilled from its liquid essence, or it may be to that kindred invisible agent that springs forth spontaneous and perfect at the touch of the drill.

CIVIL ENGINEERING.

THE Life and Career of Mr. John I. Thornycroft, the celebrated marine engineer, now known the world over for his remarkable achievements in marine construction, was made the subject of a very interesting sketch with a portrait in the *Mechanical World* (London), for November 20. Not the least interesting feature of this sketch is the portrait of Mr. Thornycroft, whose features are entirely and intensely Scotch in type, but whose cranium has been proved to contain a very valuable sort and a liberal quantity of the grey matter which modern psychologist's claim to be the seat of thought. It seems that at seventeen years of age Mr. Thornycroft gave indications of what his future would be by the construction of an iron steam launch, all the work being done in one of the rooms in his father's house, and his only helper being his sister, Miss Helen Thornycroft. The boat was named the *Nautilus*, and it was launched in the Regent's Canal, proving to be quite a success. He had however previously constructed a small model launch 8 ft long and had supplied it with the engines of a small locomotive built by his father. This model launch foreshadowed the features of the future construction with which Mr. Thornycroft has been so largely identified, he having adopted the locomotive type of boilers for his launches, and used them in preference to any other up to within a few years, or up to the time when he invented and patented his famous water-tube boiler now so largely adopted in the construction of steam launches. It may be new to many engineers that Mr. Thornycroft was the first to successfully apply the system of a close stoke-hole and forced draught, and the success which attended the application of this system has brought it into general use for both merchant vessels and warships of recent design. After the building of the model and the subsequent construction of the launch above referred to, Mr. Thornycroft started in business in a modest way at Chiswick, building there two launches, the *Ariel* and the *Slaney*, both of which, having outrun various steamers on the Thames in 1865 at a race of the University crews, brought him into prominence as a promising naval architect. At this period Mr. Thornycroft having felt the need of a more complete technical training, he closed his yard, and, after some study at Jarrow, he entered Glasgow University. After leaving the University he went for a short time to the works of Messrs. Randolph, Elder & Co., and then re-opened his yard at Chiswick. From this time Mr. Thornycroft's life has been one series of triumphs, beginning with the construction of the *Miranda*, 50 feet in length by 6 feet, 6 inches in beam, which attained the then unprecedented speed of 18¼ statute miles an hour. In fact this speed was so extraordinary as to be disbelieved by a great many people until it was corroborated by a paper read by Sir Frederick Bramwell at the Institute of Naval Architects in 1872. Mr. Thornycroft has taken out patents including an arrangement of rudders for increasing the manœuvring powers of vessels, a sort of pneumatic telegraph apparatus for conveying signals to the engine-room and for indicating speed, and lastly the water-tube boiler already spoken of, which is probably the crowning success of his life.

"The Sextant and other Reflecting Mathematical Instruments," by F. B. Brainard, U. S. N., is a worthy addition to the Van Nostrand Science Series. The History of the Sextant is first given. This is followed by a description of the instrument together with an enumeration of the various forms in use. Next the various adjustments are described and their purposes clearly elucidated. The discussion of Errors and Corrections which follows is very perspicuous. The mathematical formulæ required are few, and of the simplest character, easily understood by any one having a

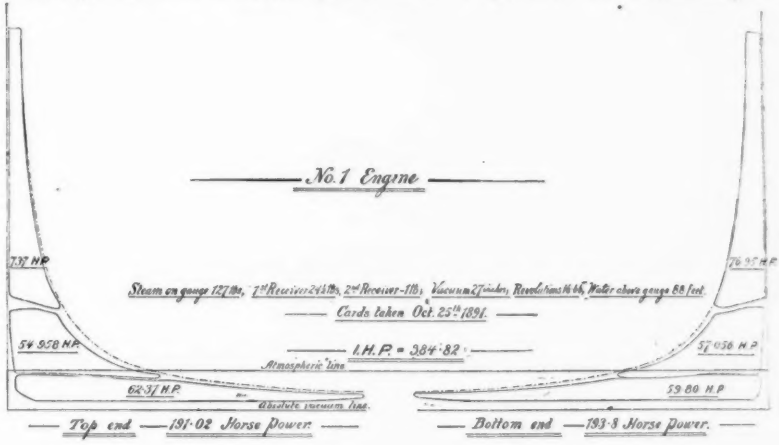
knowledge of simple equations of the first degree. The clear simplicity of diction, and the absence of any attempt at undue display of learning by the unnecessary employment of scientific and technical terms are not the least merits of the book.

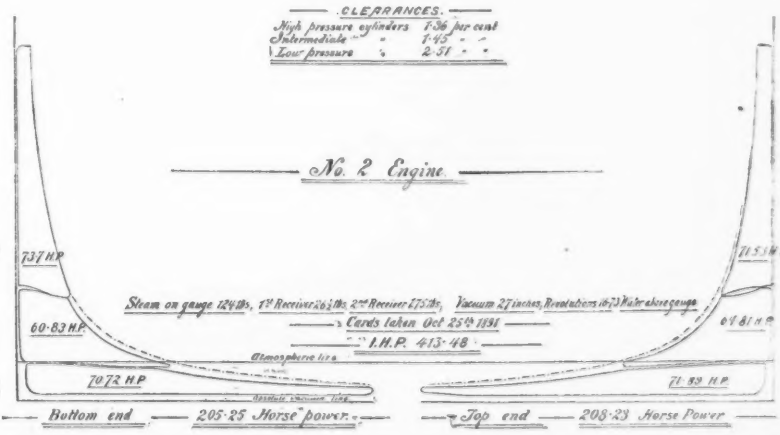
A Monster Siphon, supposed to be as large or larger than any other in use, is illustrated in the *Engineering News* for November 28th, the drawings forming the subject of illustration having been forwarded to that able publication by Mr. T. G. Dabney, Chief Engineer of the Yazoo-Mississippi Delta Levee District. The height of the center of the upper part of the bend from the center of the pipe at its beginning is 18 ft. 5 inches, and the center of the discharge end is 26 ft. 5 inches below the center of the upper part of the bend. The diameter of the pipe is 24 inches, and as the difference in head between the inlet and the outlet of the siphon is 8 ft., and the total length of the pipe is 205 ft., the discharging capacity, stated to be 26,000,000 gallons in 24 hours, is a surprisingly good result. The bends in the pipe are, however, easy and the loss from friction, at the velocity required for the delivery of the above named amount, must be nearly at the minimum. The siphon is charged by means of a hand pump through a funnel at its highest point. We have never heard or read of any natural siphon as large as this, and from the fact that Mr. Dabney asks for information of any other in operation that is as large, we are inclined to think that, at least in the matter of size, it is the most important siphon construction in existence.

"How to Become an Engineer," by Geo. W. Plympton, Am. Soc. C. E., has been recently issued by D. Van Nostrand Company, 23 Murray and 27 Warren Streets, New York, price 50 cents. The name of the author of the treatise will be at once and widely recognized as that of a highly accomplished engineer, an experienced teacher, an editor and an acceptable writer upon engineering topics. He states in his preface that he has been embarrassed by the large number of "pursuits comprehended in the inquiry" suggested by the title. He has attempted, however, "to define the proper limits to the term 'engineering,'" and to so answer the inquiry as to intelligently guide young men in their approach to this honorable profession. The title sufficiently suggests the contents of the book, and the well-known reputation of the author guarantees a clear and pointed treatment of the subject. The work is No. 100 of the Van Nostrand Science Series, and is printed and bound in the uniform style of these publications.

The Steam Power of the World has been made the subject of estimate by a foreign journal with the following results: France has 47,590 stationary engines, 7000 locomotives, and 1850 marine engines. Germany numbers 59,000 stationary engines and boilers, 10,000 locomotives, and 1700 marine engines. Austria, again, has only 12,000 stationary engines and 2800 locomotives. The horse-power of the engines of the United States amount to 7,500,000; those of England to 7,000,000; of France, 3,000,000; of Austria, 1,500,000; and of Germany, 4,500,000. These figures do not include the horse-power of locomotives, of which there were at the beginning of the year 1890 in the whole world 105,000, representing a horse-power of between 5,500,000 and 7,000,000. It is estimated that the total horse-power of the world's engines amounts to as much as 49,000,000, The average power per steam engine is that of three horses, and that of a horse is equivalent to the strength of seven men. The steam power of the world may then be reckoned as equivalent to the strength of 1000 millions of men, which is more than twice the number of workmen existing. The population of the world is estimated at 1,460,000,000 of souls. Steam has enabled the workman to treble his strength, when in a position to use it economically. It will be seen from this that the amount of steam power used in the United States exceeds by 500,000 horse-power that of England; that it is more than double that of France; about five times that of Austria, and about 3,000,000 more than that of Germany, America and England leading the world.

A Very High Duty is reported for the Reynolds Triple Expansion Pumping Engine recently tested at the West Harrison Street pumping station, Chicago, Ill., under the official supervision of Mr. Bernard Fiend, Assistant City Engineer. We have seen no record of a better duty for stationary engines, than is indicated by this test. Indicator cards which have been forwarded to us are reproduced on a reduced scale on this page and they will tell their own story to experienced engineers. The plant, built at the Reliance Works of the Edward P. Allis Company, Milwaukee, Wisconsin, consists of two vertical triple expansion engines with steam jacket cylinders, respectively 27", 46", and 70", diameter by 60" stroke. Each of these engines has three single-acting outside-packed plunger pumps 32¾" diameter and 60" stroke. The guaranteed duty was 125,000,000 ft. lbs. for each 1000 lbs. of feed-water evaporated. The actual duty obtained was 140,416,679 lbs., and the amount of water per hour per indicated horse-power was 12.675 lbs. The test was continued for eight hours and the average initial steam pressure was 124.86. This was reduced in the first receiver to to 25.83 lbs. In the second receiver to atmospheric


No. 1 Engine
7.37 H.P
76.97 H.P
Steam on gauge 127 lbs. 1st Receiver 24½ lbs. 2nd Receiver 1 lb. Vacuum 27 inches, Revolutions 14.6, Water above gauge 88 feet.
Cards taken Oct. 25th 1891.
54.958 H.P
I.H.P. = 384·82
57.056 H.P
Atmospheric line
62.37 H.P
59.80 H.P
Absolute vacuum line.
Top end — 191·02 Horse Power.
Bottom end — 193·8 Horse Power.


CLEARANCES.
High pressure cylinders 5·36 per cent
Intermediate " 1·45 " "
Low pressure " 2·51 " "
No. 2 Engine.
7.37 H.P
71.51 H.P
Steam on gauge 124 lbs. 1st Receiver 26½ lbs. 2nd Receiver 2.75 lbs. Vacuum 27 inches, Revolutions 16.73 Water above gauge.
Cards taken Oct. 25th 1891
60.83 H.P
64.81 H.P
I.H.P. 413·48
Atmospheric line
70.72 H.P
71.93 H.P
Absolute vacuum line.
Bottom end — 205·25 Horse power.
Top end — 208·23 Horse Power.

pressure, and the exhaust was made into a vacuum of 27″ of mercury.

Irrigation in Utah, according to a recent report, has extended to a total acreage of 735,226 acres out of a total acreage of irrigable land estimated at 2,304,000; or more properly speaking, 735,226 acres are covered by ditches preparatory to irrigation, while only 333,404 acres of the ditched area were actually yet irrigated in 1890. The *Railroad Gazette*, to which we are indebted for these figures, states that the methods of irrigation consist in conveying water from large streams through canals from the Bear, Weber and Timpanagos Rivers, the utilization of smaller streams flowing out of the smaller canons and valleys in the mountain ranges, and 2524 artesian wells used for the irrigation of gardens, for stock watering and domestic supply. An average depth of 879 of these wells is 145¼ feet. It is stated that a supply of 1 cubic foot of water per second will irrigate 35 acres in the very hot and sultry country of the South, while it suffices for 150 acres in the higher valleys. The average requirement is about one cubic foot of water to 100 acres.

The First Suspension Bridge built in Iceland has been erected over the river Olrusaa. This bridge is 372 feet in length and 9 feet in width. Notwithstanding its comparatively small size great difficulty was experienced in its erection, as owing to the lack of railways or other means of transportation in bulk nearly all the materials for its construction were drawn over ice on sledges from the Harbor Eyrarbakki. An exception to this method of transportation consisted of six steel wire ropes each weighing 5¼ tons and 430 feet in length, which were transported on the shoulders of men. The ropes were extended to their full length and were carried by 180 men distributed throughout their length. The distance from the harbor to the site of the bridge is 9 miles, and it took these men two days to accomplish the labor.

Plans for a New Water Works System for Kansas City have been prepared by a commission of hydraulic engineers, comprising Messrs. L. M. Holman, G. H. Benzenburg and Charles Hermany, the cost of construction being estimated at $2,425,628.50. An appropriation of $2,000,000 has been made for the work, which will undoubtedly be soon commenced and pushed as rapidly as possible to completion. The capacity of the works has been planned for 20,000,000 gallons per 24 hours, so that with an increase of the population of Kansas City to 200,000 inhabitants, the supply will be 100 gallons per capita per day; but the plans also include a provision for the supply of a surplus which will raise the daily delivery to 30,000,000 per 24 hours as a maximum for short intervals of time. Very full details of the plans are given in *Paving and Municipal Engineering*, which show that the work when completed will be a fine example of hydraulic engineering if it be constructed according to the design of the able engineers named above.

Another New Explosive of Great Power is described in the *Engineering News*, which gives it the name of "Americanite" and describes it as "a liquid compound whose principal ingredient is nitro-glycerine, the other ingredients being still a secret." It is further stated that official tests have been made with this explosive by the Ordnance Bureau of both the War and Navy Departments with favorable results. The advantages claimed are that it "is insensitive to shock and can be exploded at will." Its claim for safety is backed by the assertion that it has "withstood a blow of 27,000 foot pounds." It burns freely, but not explosively, and is not exploded by friction. It is claimed to have a force equal to that of nitro-glycerine without its dangerous properties.

The Use of Bronze for the Manufacture of German Guns, which, it has been stated, was favored by the German military authorities, will, it is said, be abandoned for cast steel, which, after a very thorough investigation instituted by the Minister of War, has been decided to be entirely preferable. Tests of the new small-calibre arms have resulted in the addition to rifles of small calibre, that of small-calibre revolvers as part of the equipment of the German Army. This kind of revolver has been subjected to very exhaustive tests.

ARCHITECTURE.

METHODS of Ventilation by Heated Flues, particularly by flues heated with gas jets, was discussed in a paper read before the Association of Public Sanitary Inspectors, held recently in London, the paper being printed in full in *Invention* of November 14. This method, as usually carried out, was made the subject of severe criticism, not generally having the capacity to increase the in-take of air and rapidity of expulsion with such facility as to accord with the varying conditions of ventilated enclosures. The installation is moreover expensive and the difficulty of preventing down-draught is great. The heat of the combustion is absorbed by the shafting before it rises many feet; the steam generated by the burning gas is condensed, the flues drop water and injure ceilings, so that the method has come to be looked upon as a nuisance and largely abandoned. At the same time, Mr. J. F. Simmance, the anthor of the paper referred to, thinks that all the faults named may be removed, and that in a properly arranged system, the installation would be cheap and its results satisfactory. To do this, however, the apparatus for the lighting of the building and the ventilation must be arranged to co-act so that expense for ventilation proper shall be sustained only at times when it is not necessary to use lights. His scheme is to place the gas-lights well up to the ceiling in relation with ventilators and to arrange them for easy lighting from below. The ventilating shafts are lined on the interior with asbestos so that the heated column of air will not chill until it finds its exit from the top of the passage. He would place a cluster of steatite burners immediately below the mouth of such an extracting shaft, which he would make to communicate with the open air either perpendicularly or horizontally, and so arrange the lights that rays will proceed from them downward at an angle of 40° from the vertical line the other rays being deflected downward by enameled iron reflectors. In this way he claims that a result of great brilliancy and economy in lighting is obtained, and the heat of combustion, which is intense immediately over the flame, would pass upward through the aperture provided, being carried along by a volume of air which will retain its temperature until it finally issues into the open exterior air. He would also arrange cowls at the outlets of the ventilating passages any tendency to a back-draught would be stopped by a system of automatic valves. He would increase the volume expelled by a method of aspiration, that is, by passages connected with the room and surrounding the ventilating gas-flames and connecting with the ascending column from the gas-burners at a point at some distance above the inlets to them; and by this means he claims that he can make the quantity of air drawn from the room controllable by simply turning a valve or tap. With regard to the facility with which he can regulate the extraction of air, Mr. Simmance makes some very remarkable claims. He states that the amount may be varied from 15,000 cubic feet per hour to 300,000 cubic feet per hour, and that a foot of gas will extract nearly 3000 times its own volume of air. He describes such a ventilating system as having been recently installed at Grosvenor Museum, Chester, England, and says extended experiments in the technical educational department of that institution showed that the temperature of the rooms did not vary one degree over that when the students entered, although remaining filled with students for some hours.

As Related to Ventilation of Buildings, the question of the altitude above the ground at which the air of cities is purest, is one which has not yet been fully solved,

and yet is of great interest to architects. Mr. W. J. Prim has been making experiments in London with a view to determine this point, and he fixes the altitude as from thirty to forty ft. from the ground. Below this point he claims that the impurities in the form of dust increase, and that above it the smoke from the chimneys contaminates the air. Mr. Prim experimented with frames of wood covered with blanketing material placed at different elevations, and estimated the amount of impurity in the air by the amount of smuts as distinguished from palpable dust deposited upon the blankets. Mr. Prim thinks that going higher than 30 or 40 ft. would be of no advantage, even if an altitude of 500 ft. were attained, and he bases this conclusion upon the amount of smutting which appeared upon blankets placed by him on the clock-tower of Westminster and at other high points, in the course of his experiments.

The Present Status of Electric Heating for Buildings has been recently discussed at length by Mr. Mark W. Dewey in the *Electrical World*. He claims that in coal, furnace, or stove-heating only about 40% of the energy of the coal is utilized; and to do even this the very best quality of coal must be used. As stoves do most of the heating in towns, and as these are not properly regulated, only 25% of the total energy is utilized. In electric heating 10% of the heat expended at the central station may be utilized in buildings to which this energy is transferred by the electric current, and if this were the only basis of estimation, that is to say, if the same grade of coal had to be used in the central power-station as that used in the stoves, the economy of the stoves would be two and a half times that of heat derived from an electric source, but the "central station can and does use coal costing one-fourth or one-third of what we must pay for coal to burn in a stove," and it is thus seen that the heat could be distributed as cheaply as it could be obtained by the direct use of stoves. Add to this "the numerous advantages of electric heating," as its entire cleanliness; its immediate readiness for use at any time; the cessation of expense for heating the moment it is no longer needed, and other obvious advantages, and it would appear that Mr. Dewey has made out a very good case in favor of this mode of heating buildings.

The Characteristics of a Home-like House, as stated in a paper by Mr. Ernest Newton at a recent meeting of the Architectural Association of London, are difficult to define. He regards it as impossible to dissect a building, and say in what particular portion or portions the home-like character is found. He regards breadth as perhaps the most marked feature in a home-like house, as "the long low building seems to fit better into a landscape" than a many-storied house. The nearer the approach made to a tower in a building, the less is the home-like effect. As in the composition of a picture, no precise rule can be laid down, and this must result from the good judgment and artistic feeling of the painter, so in building a home-like house the architect must have the home feeling strong within him. Mr. Newton thinks (of course speaking figuratively) that there is a *soul* in a building as well as a body, and that the soul is the more important study of the two. In designing home-like buildings, however, architects meet many difficulties, as want of sympathy in the individual for whom the house is to be built; a proper adaptation of the design to the site, with reference to the prospect and aspect, slope of the land, and position of trees, roads, and neighboring fields; in other words, the grasping of a motive to be worked out "quite roughly at first," but subsequently refined in detail. Things that look well when drawn do not always look well when worked out in solid materials. The general character of the house should be that of rest, quiet and simplicity. The design of a house, however small, may be "treated in a broad and simple manner and have a quiet dignity of its own."

The Enormous Annual Consumption of Glass is indicated by some statistics collated by the *Pottery and Glassware Reporter*. It is safe to say that very few people have the slightest idea of the magnitude of this consumption. The excellent

trade journal named states "that for several years past the sum of money annually paid in premiums for insurance has reached close upon $700,000, a sum representing glass to the actual value of $23 000,000. Nor does this by any means include the whole of the glass thus used, for assuredly there are many people who don't insure at all, and some who only do so partially. In a large hotel now building in New York City there will be 3600 sashes, each about four feet square, without counting the large windows on the ground floor. A still better idea of the quantity of glass used throughout the United States may be obtained from the estimate that during the coming year there will be manufactured and imported some 89,500,000 square feet of plate, mirror and sheet glass. In detail, 12,000,000 square feet of plate, 40,000,000 square feet of window or sheet glass, 4,000,000 square feet of mirrors, and 5,000,000 square feet of colored, ceiling, floor, and roofing glass. This is all to be manufactured in the United States. Then there are orders in hand abroad for importation into America amounting to 3,500,000 square feet of mirror glass, 25,000,000 square feet of window glass, and 800,000 square feet of colored, ceiling, flooring, and roofing glass."

With Reference to the Discussion upon Building Laws, which has appeared in this magazine, it may be stated that a revision of the New York City Building Laws has been undertaken for the purpose of presenting a new and amended law to the Legislature during this winter's session. This Board of Revision is formed of representatives from the American Institute of Architects, the Architectural Iron Works Association, from the Mechanics and Traders' Exchange, the Real Estate Owners Association and the Board of Fire Underwriters; the Superintendent of the Bureau of Buildings, and the Council of the Fire Department being also members of the Board. *Architecture and Building*, in an editorial upon the desirability of an amended law states that it is earnestly desired that architects should attend the meetings of the Board; as while "it is very easy to find fault with existing evils, their continuance must be placed at the doors of the complainants if they fail to take advantage of the opportunity now afforded to make New York Building laws a model for all cities."

The "Chicago Construction" is a name given to the peculiar class of buildings that originated in Chicago and which is characterized by a fireproof steel frame, the columns carrying all the load, including the walls and partitions. This structure was very well described in the paper of Mr. Edward Atkinson in the November number of this magazine, and it was made the subject of interesting discussion by Mr. W. L. Jenney of Chicago, at the recent Annual Convention of the American Institute of Architects in Boston. In his remarks upon the system and its effect upon the ground upon which it stands, he stated that "underlying Chicago is a bed of soft, compressible clay of great thickness, some 60 to 90 feet. This clay has one redeeming feature, it satisfies Professor Tyndal's definition of a solid: 'under a given load it will compress a certain quantity and stop, and the compression will not be renewed without a change in the conditions.' Experience teaches that a load of 3000 pounds per square foot will cause a compression of about 2 inches, and that it is desirable not to materially increase this load or the compressions may not be sufficiently uniform. With 3000 pounds per square foot, and with proper care in the distribution of the loads, a practical uniform settlement can be obtained with reasonable certainty." Speaking of a pamphlet published in 1873 by Mr. Fred. Baumann, one of Chicago's oldest architects, who maintained the adaptability of isolated piers to Chicago foundations, Mr. Jenney said that the "advantages of a system of isolated piers on a compressible soil is its elasticity, it being impracticable during the construction of a building to keep a uniform load on the foundations, hence the necessity of allowing the parts to settle at different times, counting upon a general uniformity of settlement in the end. A continuous foundation is liable to be broken up and very unequally; therefore, even when the pier foundations touch each other, they are

kept separate by plank or sheet piling, on the line of junction."

The Foundations of Buildings was the title of not the least interesting of the papers read at the Congress of Hygiene and Demography, recently held in London. It was contributed by Mr. Cuypers, the distinguished architect of some of the most notable and elegant buildings in Holland. His paper related more particularly to the foundations of buildings, especially pile-foundations, upon which nearly all buildings in Amsterdam rest, and which are also very largely used in other parts of Holland. He stated in his paper that the exact degree of saturation with water that will maintain piles from rotting is not yet a settled question, but that it is usually supposed that a daily submergence by the rise of the tides makes them safe. Mr. Cuypers regards this as likely to be true, but adds that it certainly cannot be depended upon where a succession of unusually low tides leaves the tops of the piles exposed long enough for the incipient rotting to begin. The capping of piles with flat stones has been abandoned in Holland, and a general basis or footing for buildings formed of timber is now bolted to the piles. This aids in preventing unequal settlement, but, for durability, the timber-footing must also be subjected to exactly the same conditions of saturation as the piles. An interesting point in the construction of some Dutch buildings as described by Mr. Cuypers is a floating cellar which he says is commonly used under houses built in the marshy lands of Holland. This cellar is enclosed within the exterior piers, being made of a timber frame, planked inside and lined with brick-work and cement. Sufficient space is left between the top of the cellar-box and the bottom of the honse to prevent it from lifting the building in cases of extraordinary high-tide.

Government Buildings, in the opinion of Mr. James H. Windrim, ex-Supervising Architect to the Treasury Department, as given in a paper read by him at the Twenty-fifth Annual Convention of the American Institute of Architects, held at Boston in October, ought to be erected in the same manner as like structures are erected by individuals, thus substituting ordinary business methods for the government red-tape which now attends the building of these structures. This, Mr. Windrim thinks, would result in economy to the public service. He claims that the duties of the Supervising Architect are really those of a clerical character, as the business part of the Department claims his attention to such a degree that questions of artistic design and engineering construction must be left almost entirely to his assistants; whereas, if the ordinary method of the acceptance of designs and the supervision of construction by the designer were were adopted, the careful and continuous thought of the designing architect could be directed to the building, thus obtaining better results than is possible with the disjointed effort necessitated by the care of many buildings.

The Sanitary Registration of Dwellings was recommended in a paper read by Mr. Henry Rutherford at the International Congress of Hygiene and Demography. He proposes that hereafter all classes of dwellings should not only be provided with a system of house drainage so arranged and constructed as to protect the inmates from any defects, a protected *indoor* water supply as distinguished from a wholesome supply at the fountain-head, but also that buildings so constructed and provided should be, on the production of a sanitary certificate granted by competent authority, entered in some competent register. This plan, it would seem, provides for a thorough sanitary inspection before occupancy of buildings, and the maintaining of a record of the appliances for drainage and water supply which they contain. The point might be worth considering by the Board of Revision now discussing amendments to the present New York Building Laws with a view to the presentment of a draft of an improved law with petition for its enactment, to the New York Legislature this winter. If such a law be drafted it should cover the whole ground, imposing penalties alike for violation of sanitary rules, and for official neglect in the inspection and registration.

ELECTRICITY.

YEAST Culture, as aided by the electric light, is discussed in the *Electrical Review* of November 13, which quotes the *Brewers' Journal* as authority for the statement that yeast flourishes far more vigorously in a well-lighted fermenting room than in one that is altogether too small, and in which the atmosphere is close and the light feeble or nothing. The recent application of electric light in retaining the vitality of tropical plants in their transportation during long voyages has suggested the benefit that might be derived from the electric illumination of fermenting rooms in breweries wherein either gas or oil illumination would be impracticable on account of the gases generated by them.

The New French Storage Cells of the Société Anonyme pour le Travail Electrique des Metaux will, according to the *Electrical Engineer*, be likely to "carry dismay and envy into the ranks of accumulator monopolists, and to make traction companies wonder why they bound themselves to any make of cells when the possibility is now demonstrated of the procuring of cells, weight for weight, of four times the capacity of any known accumulator." The plates of these accumulators are, according to the journal quoted, "made of grid pattern, with square holes filled in with reduced lead of great porosity. Chloride of lead and chloride of zinc are melted together and the fused salts moulded in cakes of two inch square of desired thickness. The cakes are formed with cross grooves on both sides and a small hole through the center. When cool they are removed from the mould, laid in batches between perforated iron plates and placed in a bath of hydrochloric acid for 15 days." The acid dissolves out the chloride of zinc and after drying the cakes they are placed in moulds and molten lead poured in, forming a framing as the lead runs into the groove on the faces of the blocks and into the small holes, thus producing "a self-supporting plate of good conductivity." After trimming up, the plates are arranged in a solution of chloride of zinc with interposed zinc plates, by which means the chloride of lead in the squares is reduced to porous metallic lead, the chloride of zinc being entirely removed by the hydrochloric acid. The process of reduction and cleansing is completed by thoroughly and alternately washing the plates with pure water and with acidulated water. Finally the plates are subjected in the usual way to electric currents, and it is said that the capacity reaches the extraordinary figure of 10 ampere hours per kilo, which is equal to 4½ ampere hours per pound. It is further stated that these accumulators have been adopted by the French Government after most severe tests.

The allowance of the Berliner Microphone Patent has produced a profound sensation throughout the country, and with reason. In the first place the methods by which this patent has been kept before the Patent Office for, we believe, the unprecedented period of fourteen years, are unparalled in the history of the United States Patent Office. The fact that this method of procedure is possible is not only demonstrated by the success attending the effort to postpone the issue of the patent, but it was also clearly pointed out in the excellent paper of Mr. Allison, entitled "One Hundred Years of Patents," published in this magazine for June 1891. Mr. Berliner has himself told the story of his invention. It was published in the *Electrical World* for November 28, and is interesting reading, as showing his course of thought and reasoning upon the subject of transmitters, and interesting also in connection with other statements made the subject of a very searching criticism from

the pen of Mr. Park Benjamin, published in the New York *Evening Post*. The full text of the patent as allowed to Mr. Berliner was published in a supplement to the *Electrical Engineer* for November 17th, the the following claims subject to the preceding disclaimer having been granted.

Disclaimer.—I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing.

Claims.—1. The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

2. An electric speaking telephone transmitter operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.

3. The combination, with the diaphragm and vibratory electrode, of a rigidly held opposing electrode in constant contact with the vibratory electrode, substantially as described.

4. In a telephonic transmitter, a vibrational plate made concave for condensing the sound, substantially as set forth.

5. In a telephonic transmitter, a vibrational plate provided with one or more apertures, as and for the purposes set forth.

6. A speaking-telephone transmitter comprising a diaphragm or disc sensitive to sound waves, combined with a rigidly held but adjustable electrode in contact with the same, whereby the electric current is transformed into a series of undulations corresponding with the vibrations of said diaphragm.

Upon the allowance of these claims the Bell Telephone stock took a jump of 15 points in scarcely more than as many minutes; but although fluctuations of stock are often indications of sound judgment, we cannot in this case admit that there was a justification for this remarkable increase of value. It is impossible that the re-action upon the business of the Bell Telephone Company, which would be indicated by such an advance, can exist in the claims allowed to Mr. Berliner. The views of Mr. Herbert Laws Webb, as printed in the Department of Electricity in the October number of this magazine show that their business tenure depends upon a great many other things than the allowance of a patent for a transmitter. We are of the opinion that independently of the allowance of this patent the company will hold the field long bevond the expiration of the Bell Telephone patent; but the manner in which the patent has been delayed in the Patent Office indicates a danger to the rights of the public, as well as to the rights of inventors, in so emphatic a manner, and so plainly shows a defect in our Patent Office methods, that we shall confidently anticipate an effort to be made sooner or later for an amendment of the law that will prevent such delays in the future.

The Beginnings of Pictorial Telegraphy are apparent in the results obtained by Mr. N. S. Amstutz of Cleveland, Ohio, who has called the process by which he produces his pictures the Electro-Artograph. *Electricity*, in its issue for November 18, gave fac-similes of the pictures produced by Mr. Amstutz with an explanation of the methods by which he accomplishes the results. The inventor makes use of what is known in photography as a "stripping film" which is made of gelatine and bichromate of potassium. Upon this film the picture to be transmitted or telegraphed is first photographed, and then, by treatment with water, the portions of the film not acted upon by light are dissolved out, leaving the other portions in relief. The amount of relief is thus seen to be in exact proportion to the light which has acted upon the gelatine, the surface of the film representing all the variations of light and shadow in the picture. This film is used as a part of the transmitting apparatus, being mounted upon a cylinder having a uniform revolution, and arranged in relation with a stylus automatically operated in such manner that the point of the

stylus passes over every part of the wax cylinder. By an ingenious method Mr. Amstutz causes the currents of electricity to undulate or vary in exact accordance with the motion of the stylus produced by the parts of the mounted film, and the picture is reproduced at the farther end of the line by a receiver operating on the same principle as the transmitting apparatus, except that the action is reversed, the stylus of the receiver being practically an engraver. The engraving stylus acts upon paper, which, being coated with hard wax, is mounted on a cylinder actuated in the same manner as the transmitting cylinder that carries the prepared gelatine film. The pictures so far produced are exceedingly imperfect in detail, but the indications are favorable for reaching better results.

The Commercial Practicability of High-Pressure Electric Distribution has been discussed by a writer in *Nature*, who has even gone so far as to state that long-distance transmission by high-pressure alternating currents and transformers is commercially "a dreary failure." As an instance, he recites the results at Deptford, England, where the transforming of pressures, first to 10,000 volts and then a double reduction of pressure to supply London consumers, results in an alleged large loss of power. The *Electrical Review* (London) replies to this criticism that it is "premature." It points out that the Deptford installation was "planned and carried out in every detail under very exceptional circumstances. There was absolutely no experience to draw upon in constructing and installing a plant for the generation and distribution of alternating currents at 10,000 volts pressure, and the scheme altogether was planned on a very gigantic scale, so that the expenditure of time and money has been necessarily on the same scale." The journal quoted thinks that the questions, "whether 10,000 volts is too high a pressure for practical use;" and "whether the saving in copper in the mains is not far more than overbalanced by the increased cost of insulation throughout the plant," are likely "to be decided by the results of the working of the Deptford installation." It further points out that 'high pressure saves the copper in the mains only, but it adds to the cost of insulation all over,—in dynamos, mains and transformers." Another question likely to be decided by the Deptford experiment (for commercially speaking it was and is an experiment) will be, whether generators of the size proposed by Mr. Ferranti are better than more numerous and smaller ones or the reverse. On the whole the *Electrical Review* thinks that "time must elapse before any decided conclusions can be drawn from the working of the Deptford scheme."

An Electric Punkah, which must prove a peculiarly grateful luxury in the torrid climate of the East Indies, has been brought out by Frank J. Agabeg, and is illustrated in *Indian Engineering* under the facetious title, "Punkah Pulling Considered as a Fine Art." The punkah is pivoted longitudinally over the bed and vibrates in an arc from 150° to 160°. By means of an ingenious link motion the fan gets a slow and quick-motion alternately, which exactly imitates the jerk and swing-back of the ordinary punkah as manipulated by muscular power. The electric power is furnished by batteries, the cost of which for from 18 to 20 hours is about the same as that which would hire two coolies for the purpose. It may be arranged to fan the air over dining tables as well as beds, and the comfort of dispensing with the attendance of the coolies while the fanning proceeds uninterruptedly, will doubtless bring the invention into rapid use in the East Indies. It should be said, however, that the battery cells which work the punkah are also capable of lighting up a three to four candle-power electric light at the head of the bed, so that if desired the occupant may read with perfect comfort.

"A Century of Electricity," by T. C. Mendenhall, Superintendent U. S. Coast and Geodetic Survey, was the first of the books published by Houghton, Mifflin & Co., known as the Riverside Series, but it has been revised and some errors which crept into the first edition have been corrected. The scope of the history

(for such is largely the character of the work) includes the progress of electricity both as a science and an art from the beginning of the 18th Century down to the present brilliant era. In explaining electrical appliances, the author makes no attempt to enter upon the discussion of abstruse principles by the use of mathematics. His elucidation of many things which greatly puzzle those unfamiliar with the applications of electricity, are, however, in most cases, very clear; as notably, his explanation of duplex telegraphy accompanied by a diagram on page 116. It may be remarked, in this connection, that a liberal use of engravings and diagrams has been made wherever these can help the reader's comprehension of the explanations. The work is not intended to instruct electricians or electrical engineers; but it is admirably adapted to give such information to the general reader as must be desired by those who, while not seeking or expecting to obtain a profound knowledge of the subject, yet wish to know enough about it, to comprehend the wonderful industrial revolution now in progress and resulting from the ever increasing number of the applications of electricity to useful purposes.

An Ingenious Invention for Removing Ice from Trolley Wires has been recently described in the *Western Electrician* with engravings. To the trolley pole is pivoted a vibrating hammer which is actuated by a tappet driven by the trolley wire in such manner that the hammer constantly strikes against the wire, thus producing a vibration which rapidly detaches the ice. Nearly every one has perceived how rapidly ice may be detached from a stretched cord or wire by slight taps which cause it to vibrate throughout its length, and the invention named appears to have been based upon this principle.

Carrying Coals to Newcastle is a phrase that has received a recent exemplification in the introduction of the electric light into the gas-works of the Dewsbury Corporation, England, believed to be the first instance in which electrical illumination has been used as an accessory to the manufacture of illuminating gas. The lights have been placed in the purifying house found to be inadequately lighted by safety gaslights placed in the walls. Mr. Charles A. Craven, the engineer and manager of the gas-works named, is reported in the *Electrical Engineer* (London), as making the following statement with reference to the adoption of the electric light:

"Some of my brethren in the gas profession seem much struck with the novelty of the idea. I am told that it is 'a funny thing to bring the electric light into gas manufacturing operations.' Well, I reply that our gas is frequently used in providing motive power to produce the electric light; and that being so, why should not we utilize the light for any purpose where it can advantageously be used? If I dare put gas lights where I have placed incandescent lamps, I could get as much light as I want, and at a cheaper rate than by using the electric light. Our surplus power, however, enables us to produce the light without much extra cost. We are intending to make some few additions to the fittings of the lamps, which will add somewhat to the cost, but which will at the same time be an additional safeguard."

Another Patent that has made a Sensation, granted August 3, 1874, by the Canadian government to Messrs. Henry Woodward and Mathew Evans, has been unearthed, and was published in the *Electrical Engineer* (London) November 20th. The specification has also been published in many other electrical journals, and it clearly shows that the method of installation by exhaustion or by the interposition between a glass globe and a contained electric conductor of a gas or vapor having no chemical affinity for the conductor, as well as the arrangement of lamps in parallel series existed before either Edison, Maxim or Sawyer-Mann had reached any of these principles; that is to say, as far as any published record of their researches discloses. At this writing, we have seen no response to this publication from either of the eminent electricians named or from persons representing them.

The Utilization of the Power of Niagara Falls on the Canadian side and the distribution of the power by electric currents of high voltage will probably soon be undertaken.

MINING AND METALLURGY.

PHOSPHATIC Chalk at Taplow, England, has been described in a recent number of the *Engineering and Mining Journal* by Mr. Walter B. M. Davidson, A. R. S. M. The article is in substance a review of a paper previously read by Mr. M. A. Strahan before the Geological Society of England, which predicted, that, as with the exception of phosphatic nodules or so-called coprolites in the upper green sand, there were no other phosphatic deposits yet discovered in England except those at Taplow, the latter might become a valuable source of supply for the English market. Mr. Davidson states in his article, that, as a result of Mr. Strahan's paper, some English capitalists undertook to explore the discovery, the results of their prospecting not yet having been made public. The deposit exists in "two bands of brown phosphatic chalk," the upper being 11 ft. thick, the lower 4 ft. thick, with 12 ft. of hard white non-phosphatic chalk between them. The color of the material is brown,—due "to a multitude of brown grains; and under the microscope these grains are seen to be almost entirely of organic origin." A chemical analysis shows that the material contains from 18 to 35% of phosphate of lime. The brown tint of the grains found in the material is attributed to the presence of humic acid, and these grains contain also by far the greater proportion of the phosphate of lime, about 50.6%. Mr. Davidson states that they are also readily separated by pulverizing the rock, and washing with water. Mr. Davidson also points out that phosphatic chalks now worked in France resemble greatly the Taplow deposits, and it appears from his article that an important commercial development of these deposits is possible in the near future.

The Laying of Coal Dust in Mines was discussed in a recent paper read by Mr. R. B. Mawson before the Manchester (England) Geological Society. In this paper he described a system in use in English coal mining which is, substantially, spraying with water, the difficulty met with being the atomizing of the water to a spray of sufficient fineness. The first experiment in dividing the water was the use of gas-burners, through which the water was forcibly ejected, but these did not effect a sufficiently minute division. The floors of the mines therefore became very wet around the bottoms of the stand-pipes. This injured the roads in the mines to such an extent that the gas-jets had to be abandoned. A great many substitutes were tried before sprays of sufficient fineness could be obtained. Success has been reached by the use of lead plugs screwed into the ends of pipes and then cut off. Holes are then made through lead plugs by driving through them a fine steel drift which not only makes the hole required, but swells the lead in the hole so that it will resist any pressure of water without blowing out. Any required fineness of jet is obtained by simply upsetting the face of the lead plug with a hammer. The result is, that sprays without water-dropping are produced, resembling fog, and dampening all the loose dust. The sprays are directed against the wind, which assists in further atomizing the water. The effect of each jet is for a distance of about fifteen yards, rendering the dust so damp that a handful of it lifted and thrown down falls in a mass instead of breaking up into suspended particles. It was brought out, in the discussion of this paper, that a collateral benefit was derived from the cooling of the faces of the mines. In some of the pits of South Wales a lowering of temperature from 8° to 10° has been thus attained. It was further brought out that the application of the lead plugs was exceedingly cheap as well as efficient.

The Use of Telephones in Mines is predicted on the ground that the expiration of the telephone monopoly will cheapen

telephonic apparatus and that the availability of this method of communication for mining purposes will be likely to greatly extend its use. With regard to the expiration of the telephone monopoly, we regard the statement as chimerical, as the practicability of telephonic transmission depends upon numerous minor patents other than the patents of Bell and Edison. There is, however, no doubt that some time or other this method of communication in mines will come into extensive use. *Invention* (London) has enumerated some of these uses in an editorial article upon the subject and points out that it could be practically utilized for communicating between the head-office at a colliery and the weigh-cabins, stores, pit-tops, and managers' houses, thus saving much time and running about. The chief difficulty in making any of these applications would be found in the weigh-cabins, which are noisy places, and would therefore require a powerful apparatus. The greatest utility would however be in communication between the surface and the pit-bottom, and between the surface or pit-bottom and the engine-planes or working-places. At present, in many mines, ladders or man-engines are the only means of ascent and descent, and a large amount of time is consumed in making any communication between the surface and the interior of the mine. In the case of a mine accident, communication by telephone from the surface could be made with those in the interior; and when personal injuries occur in the mines, surgeons might be summoned in very much less time than is possible under existing systems. Doubtless there will be some practical difficulties in making all these applications, but there appears to be nothing which should not be finally overcome in the present state of engineering resources.

Texas Lignites are Discussed at Length in a recent number of the *Manufacturers' Record*, from which we gather that the lignite area in Texas is 500 miles in length and from 20 to 100 miles in width. The State Legislature at its last session made an appropriation for the purpose of sending Mr. E. T. Dumble, the State Geologist, to Germany and other countries to enable him to study the industrial uses to which lignites are applied. The result of Mr. Dumble's investigations, as reported by him, comprise, among other things, the fact that the Texas lignites are applicable as fuel for all manufacturing purposes, including iron and steel works, and it is now thought this application will render available, at low cost, the deposits of ore at Llano, New Birmingham and other parts of the State. Mr. Dumble found that in Germany last year 15,000,000 tons of lignite were mined, the value of this fuel being $10,000,000, and he found that this fuel was in use for household purposes, for manufacturing and metallurgy, in fact everything except the smelting of iron ores and production of pig iron. He bases his opinion that the Texas lignite is suitable for metallurgical purposes upon the fact that a comparison of it and the Bohemian brown coal shows it to have a similar chemical composition and that his opinion as to its utility has been confirmed by the highest Austrian and German authorities. The *Manufacturers' Record* judges that this report is worth millions of dollars to Texas, Arkansas and other lignite regions.

"Geodesy," by J. Howard Gore, Professor of Mathematics in Columbian University, published by Houghton, Mifflin and Company, is a historical work of special value, as the data for it have been collated from original reports in the library of the Columbian University, which are nowhere else to be found. The author states in his preface that he has attempted no more than a historic sketch; and he announces his intention to follow it, at a future period, with a critical history. The data for the present work are all taken from first hand. The history commences with the primitive notions of the size and form of the earth including those of the ancient Hindoos. It then gives an account of the primitive determinations of the size of the earth, the beginnings of accurate determinations, and the earlier theories regarding its mathematical shape. After a review of geodetic operations in what might appropriately be called the infantile period of the science of geodesy, follows the

narrative of solid work done in England, France, Russia, Sweden and Norway, India, Prussia and the United States, culminating in the splendid work of Prof. Harkness of the United States Navy, whose determination of the form of the earth, called the Harkness Spheroid (first mentioned in print in this work), the author predicts will soon supplant all others.

Of the New Explosive Ammonite, very interesting developments are published in *Invention* (London), which describes successful experiments performed at a quarry at Oakham near Dudley, England, in the presence of a large number of mining engineers and proprietors from the neighboring collieries. The quarry contains a basaltic rock known in England as "Rowley rag," and one of the experiments, considered the most important, consisted of blasting out a huge solid column of this stone estimated from measurement to weigh fully 600 tons. The blasting was performed without drilling, the charge of 60 pounds of the explosive being placed in a fissure at the base. The fissure was then clayed up and the explosive was discharged by means of a fuse. The firing of a 29-pound shot from a mortar to test the relative strength of ammonite as compared with dynamite, the charge being 5 grammes of each explosive, resulted in a projection of the shot through a distance of 337 ft. by the ammonite charge, while the dynamite charge only projected it 310 ft. As showing the safe character of this explosive, experiments were performed by burning the ammonite in a brazier, striking it with a sledge-hammer on an anvil, and by firing rifle-bullets into a box containing the explosive. The material withstood all these tests. The general opinion of the mining experts present is stated to be that the safety as well as the effectiveness of this explosive was fully demonstrated.

Allotropic Silver of the yellow variety and much resumbling gold in appearance has been produced by Mr. Cary Lea, of Philadelphia, who has sent specimens to the French Academy of Sciences. Some injustice has been done to Mr. Cary Lea by the assumption that he supposed that this allotropic form of silver was identical with gold. For instance, the *Mining and Scientific Review* speaks of the substance as "*manufactured gold*," and, in an editorial upon the subject, uses the expression "the days of alchemy are upon us." Moreover, it shows a misunderstanding of the subject when it states that the specimens sent by Mr. Lea to the French Academy possessed the characteristics of gold, immediately thereafter stating that these characteristics disappear under certain manipulations and tests, among which are striking it with a hammer, and subjecting it to intense heat Anything possessing the characteristics of gold unreservedly would be gold to all intents and purposes; but a characteristic of gold which the allotropic form of silver does not possess, is that it *permanently* possesses its physical and chemical properties so far as any experiments have yet been able to show. It seems, however, that this discovery of Mr. Lea's has been anticipated by another French chemist, who claims to have produced gold from silver by certain manipulations with nitric acid aided by light. There is little doubt however that this imitation of gold is likely to renew in many minds the dreams of the old alchemists; and it is certain that we have not yet any scientific warrant for asserting that gold is not a composite substance, except the one fact that we have never been able to resolve it into other elements. In this it ranks with all the other so-called chemical elements, each of which is called an element simply because it cannot yet be proved to be of complex character.

A Report on Mine Ropes has been made to the French Government, which states that ropes of hemp or of aloes fibre are almost exclusively used in Belgium. These ropes are guaranteed to last from one-half to two and one-half years, any premature failure resulting in a deduction of from one-twelfth to one-twenty-fourth of the cost of the ropes for every month they fall short of their guaranteed duration. As to steel wire ropes, the report states that they should be made of crucible steel having a tensile strength of 70 to 76 tons per square inch and that the diameter of pulleys for use with iron wire ropes should be from

1300 to 1400 times the diameter of the wire, of which the rope is made. For steel ropes the diameter of the pulleys should be 2000 times that of the wire of which the rope is made. Whether of steel or iron wire the ropes should have hemp cores to render them more flexible.

The Jones Mechanical Puddler is an ingenious invention which has been recently patented in this country and in England, and which is claimed to do the laborious work of puddling perfectly. The principle of the invention is the employment of a puddling furnace or hearth which is given an oscillating motion by means of a cam movement attached to an upright shaft. The metal is thus continually agitated on the hearth and rolled about. The carbon is oxidized out of it without any manual labor. As the iron "comes to nature" it is accumulated upon a nucleus consisting of a ball of wrought iron of the same character as that undergoing the puddling processes, gathering as soft snow gathers upon a ball rolled about in it, and thus accumulating a quantity sufficient for operation under the hammer. This appears to be an important attempt to obviate the severe physical labor which has hitherto attended the operation of puddling.

The Tin Mines of the Black Hills have been investigated by an expert who has reported to the St. Louis *Hardware Reporter* that a large amount of money has been sunk in the Harney Peak enterprise, this fact being mentioned as indicating the unbounded faith of investors. This expert very wisely remarks that "it is safe to assert that the only question affecting the success of the Harney Peak Company will be the question of cost of production." He thinks that the lode at Hill City is uniformly rich in tin.

Modern Iron and Steel Works are to be introduced into China, a contract with an English firm having been made for the supply of a complete Bessemer plant, to include two 5-ton converters with cupolas, blowing engines, cranes and other machinery. The contract also includes the supply of the machinery for a large rail-mill, a plate-mill, a bar-mill, twenty puddling furnaces, and two blast furnaces of the Cleveland type, the whole being for an output of 100 tons of pig-iron daily. These works are to be located near the city of Hankow on the slope of the Hanyang Hills. It is further stated that a foreign technical staff for the conduct of these works has been secured. Some of our contemporaries seem to regard this as an opening wedge for the entrance of modern civilization into the Chinese empire.

Examples of Methods of Mining, of shaft sinking, drifting, stoping, timbering, hoisting, ore-handling—in short all that represents advanced mining in methods and processes, according to the report of Mr. Charles D. Lawton, Commissioner of Mineral Statistics for the State of Michigan, may be seen in the Lake Superior regions, and equally in both iron and copper mines. He claims that the mining work in the copper mines is of the highest order, and that the manipulation of the mineralized rock has been brought to the utmost degree of production. This advanced state of the mining art he attributes more to the use of the air-drill and giant-powder than of any other agents. By the use of the air-drill holes are bored to a depth of 10 or more feet, and several sticks of giant-powder are used in these holes in single blasts which, upon exploding bring down enormous masses of ore and rock.

An Electrical Indicator and over-winding alarm for use in mines has been brought out in England, and it is said that it will sufficiently notify the approach of the cage in the shaft to the surface to prevent over-winding. The principle of the apparatus is a worm-wheel on the end of the drum-shaft which moves a finger round a circular plate in front of the attendant, the index-finger in its revolution reaching contact-pieces through which an electric circuit is completed and an electric bell rung. The position of these contact pieces on the dial is variable, so that they may be adjusted to different lengths of ropes on the winding-drums, and it is claimed that this adjustment for different lengths may be effected in one-quarter of a minute. This indicator seems entirely practicable in its application to the purpose named.

MECHANICS.

A CRITICISM entitled "More Electrical Nonsense" is made by Mr. Fred. H. Colvin in the *Locomotive Engineer* for December, upon a statement made by Mr. Frank J. Sprague, who asserted in a recent article that "break a single part of the many in a locomotive and it is helpless, while many of certain parts of an electric motor may be broken and, though crippled, it will still operate." Mr. Colvin very justly ranks this statement with that of Dr. Louis Bell; to wit, that there are 64 oil holes und eran engine and that "failure to oil any one of these means accident and perhaps death to the train." As exhibiting the erroneousness of Mr. Sprague's statement, Mr. Colvin says "the hundreds of engineers who have come home 'on one side' from various causes know well that it takes more than the breakage of a single part to make them helpless," and he concludes his criticism with the pithy sentence, "you can fool all the people some of the time, some of the people all the time, but you can't fool all the people all the time."

"Heat as a Form of Energy," by Robert H. Thurston, Director of Sibley College, Cornell University, published by the Riverside Press, Cambridge, has 258 pages, exclusive of the preface, table of contents and index, 129 being devoted to "Heat Transfer and the World's Industries"; "Air and Gas Engines—Their Work and their Promise," and "The Development of the Steam Engine." The discussion of these topics, with which the author is eminently competent to deal, and in which he has adopted the popular style of treatment characteristic of the Riverside Science Series, fills three chapters, having titles above quoted. "The Philosophers' Ideas of Heat,' and "The Science of Thermodynamics" to each of which topics a chapter is devoted, form an approach to the subjects treated in the chapters first mentioned; while in a final chapter, entitled "Summary and Conclusions," the author traces our present store of fuel back to "potential activities of former geological ages"; attributes "the philosophy of the steam-engine" to the work of scientific men of the nineteenth century; compares the theoretically perfect engine with the necessarily imperfect ones represented in even the best modern types; discusses many interesting topics connected with the conversion of heat into mechanical energy, and, in tracing heat back towards its ultimate original source or "Great First Cause," pronounces this "beyond the domain of Science, which, whatever else it may be, 'can never be teleological.'"

The Viscosity of Oils, the property by which fatty matters become valuable as lubricators, has been made the subject of investigation by the German chemists, Messrs. G. Kraemer and A. Spilker, who have determined by their experiments that the viscidity of oils depends upon the number of methyl groups contained in them. Methyl alcohol is a very thin fluid substance and it is the chemical starting point of the so-called fatty acid series. As the methyl groups increase in this series of compounds, the oils become denser and more viscid. They have also determined that the viscosity of the oils may be increased, and they claim to have produced an oil which possesses a viscosity degree of 700 as determined by the viscosimeter, that of the best Russian lubricating oil, so far as heretofore known, possessing a degree of only 40. It is questionable, in our opinion, whether a viscosity degree of 700 would not be excessive in a lubricant, a certain degree of fluidity being as essential as viscosity.

A New Lubricant Bearing for Machinery has been made the subject of investigation by a Committee of the Franklin Institute, consisting of Mr. H. R. Heyl, *Chairman*, J. Sellers Bancroft, Thomas P. Conrad, Philip H. Fowler, Luther L. Cheney,

Stockton Bates, H. W. Spangler and S. M. Vouclain. Prof. Coleman Sellers has made a previous report on these bearings, which was so highly favorable that an official examination was deemed desirable. In his statement Prof. Sellers said "that the co-efficient of friction is lower than that of many oiled bearings in good condition and well attended to. It is doubtless lower than with metal bearings as usually operated with moderate attention and poor qualities of oil." The bearing is intended to be used without oil, although as stated by Prof. Sellers in another part of his report, oil may be used if desired. The Committee above named found that the materials employed in the manufacture of these bearings, which are principally graphite and saw-dust, are obtainable in the open market, and their source of supply in the United States is practically inexhaustible. They found also that the ratio of friction "is much less than with well oiled metal bearings and greatly superior to the result obtained in common practice, thereby effecting a great saving in power even in comparison with the most carefully attended metal bearings. They state that the co-efficient of friction "is practically constant, being no greater at starting than when running at any speed, which cannot be said of any oiled metal bearing;" and that the "material may be moulded into any desired form with the nicest accuracy of finish so that all forms may be infinitely duplicated with standard precision without the necessity of touching a tool to them." From the character of the gentlemen who made this report it must be accepted as conclusive that a very important addition to the resources of mechanical engineering is furnished in this new invention.

A Boiler Explosion, resulting from a singular cause, is described in the English papers. It appears that the steam-domes of several boilers in a battery were connected by pipes leading from the sides of the domes. In making connection of the pipes a stout rubber gasket was used, which was shaped neatly to the outside of the flange; but, through the inadvertence of the engineer it had no hole cut through its centre. It thus formed what mechanics call a "blind flange," and had it been exposed to the entire pressure of the steam in the boiler it would undoubtedly have burst through; but as it was exposed to steam pressure on both sides, the additional pressure in the boiler thus hermetically sealed, was insufficient to burst it. The gasket was subsequently examined and found to be unbroken, exactly as it was applied.

A "Scab," "Copper-head," "Snake-in-the Grass," are appellations which Mr. Albert Phillips of Toronto, in the *Monthly Circular of the Stone Cutters Association of North America* considers as too good to apply to the man who does more work than the average man. The opprobrious terms named are usually applied to those who work for under-pay, but he considers them as praiseworthy as compared with the man who does more than his fellows. He quotes the remark often heard among assemblages of workmen, "Bill spoiled this yard; it used to be a good easy shop before he came." As a maxim for workmen to follow, Mr. Phillips advises "*Keep your place and consider it two hats behind.*" This language is easily understood although it contains some slang, It means this: Rather than excel *seek inferiority*. It is a crime to do more than an average workman and a virtue to seek constantly to lower average efficiency. Probably Mr. Phillips would also add that while an effort should be constantly made to lower average efficiency a constant effort to raise the average wages should go hand in hand with it, that thus the ultimate and most desirable end of obtaining a "*good easy shop*" should be reached. We mention this, as the latest outcome of trades-union ethics.

The Finishing of Bearings by Emery Grinding often results in more or less retention of the emery in the metal so finished, and when they are put into use causes them to cut, sometimes disastrously. If the bearings be of iron it is stated that if they are placed in a lathe and worked over with a blunt tool of brass of somewhat less hardness than the iron, the emery will stick in the brass in preference to the iron and thus may be extracted. It is

further stated that if the bearings be of steel, a tool of soft iron may be used exactly as described for the brass tool, and that this is a cure for the difficulty named. The writer tried this method on some bearings with apparent success; but, as he is not able to tell positively that the bearings would have cut had they not been thus tooled, the feasibility and effectiveness of the method is regarded as yet unsettled.

The Scarcity of Skilled Draughtsmen is indicated by a statement in *Industry*, an excellent mechanical monthly published in San Francisco, which in its latest issue states that it is in receipt of letters from the East asking its editor to recommend such draughtsmen for open situations. The paper named regards this as very significant, as indicating the fact that average draughtsmen are at the present time incompetent to perform the general duties of their profession. It cites an example where a competent draughtsman who was offered alternative situations, arranged to divide his time between two different offices; and it takes the opportunity to "remind students and apprentices that machine drafting is not a direct profession or even an artistic art, but simply a means of presenting graphically what the draughtsman knows and has learned of practical instruction." Mere ability to make smooth lines, to join them perfectly, to compute strength of materials, to delineate objects accurately upon drawing paper, does not constitute a competent draughtsman. It is necessary that he should have practical knowledge of mechanical work as performed in the best modern shops, and his designs must be made with reference to their proper and efficient production when they reach the shop. He may obtain general ideas from sketches supplied to him by competent designers, but to be valuable as a draughtsman he must be able to work out the details of these sketches under the guidance of practical experience. We can confirm the fact of the scarcity of such draughtsmen, as we are frequently in receipt of inquiries similar to that mentioned by our contemporary.

An Interesting Device to be used as a substitute for a split-pin is described in *Invention* (London) in its issue of October 31st. Instead of boring a hole through the end of a bolt for the insertion of a split-pin to hold the bolt in place, an annular recess is turned in the bolt, the inner shoulder of which is flush with the surface of the piece through which the bolt is inserted. A conical ring, with a spring temper, cut through on one side, is then slipped over the protruding end of the bolt into the recess until it snaps into the recess, the base of the ring resting against the surface of the piece through which the bolt is inserted and outside of the diameter of the bolt. The drawings accompanying the descriptions referred to show that a very neat finish may be made in this way, and it seems a highly practical method of fastening bolts or locking nuts in place.

A New Weighing Machine has been designed by an English inventor. The principle of this machine is that of the hydraulic displacement of mercury in a tube. The article to be weighed is hung upon a hook that is connected mechanically to a plunger arranged to float in a bath of mercury. The added weight causes the plunger to descend in the mercury to a point at which the increased height of the liquid around the plunger counterbalances it. The amount of this descent is indicated by an index finger arranged in relation with a graduated scale. Certain practical difficulties in the operation of this apparatus suggest themselves. In the first place it would seem that the amount of mercury required would cause the apparatus to be too expensive. Secondly, no provision appears to have been made for the prevention of oxidation of the upper surface of the mercury which, if it be allowed to take place, will constantly alter the accuracy of the indications on the graduated scale.

The Use of Forging Presses for the production of heavy steel forgings is said to produce very much better results than the employment of a steel hammer. A paper read by Mr. W. D. Allen on this subject before the Iron and Steel Institute states, that under the action of the hammer the external surface of an ingot absorbs a large portion of the impact of the blows; whereas the compacting of the metal under the

press extends to the very interior of the mass. In his paper he describes a forging-press in which the force pump and the main cylinder communicate directly, without intermediate valves, and in which the ram rises and falls through a stroke of 2⅞ inches and moves synchronously with each motion of the pump, producing a pressure of three tons to the square inch.

A Deserved Criticism is made in *Invention* (London) upon the names of machine-tools as used in the United States. These names are very confusing. For instance, a drilling machine is often called a *drill;* whereas a drill and a drilling machine are really distinct, a drilling machine being a machine for operating a drill. *Invention* suggests that if drilling machine is too long a name, *driller* might be substituted in the same manner as the words *planer* and *shaper* have been substituted respectively for planing machine and shaping machine. However, this criticism is open to the objection that *driller* applies also to a person attending a drill; an objection which also lies against the words *planer* and *shaper;* and the authoritative revision of the names of machine tools and the adoption of less confusing terms appears desirable. However, our English brethren should extract the beams from their own eyes before looking at the motes in American eyes. English terms for various machines and tools are not only unique, but, in many cases, almost unintelligible to American readers.

A New Process for the Protection of Iron Surfaces against rust has been brought out in France, the important feature of which is, however, not new, as it is the formation of magnetic iron oxides upon the surfaces to be protected. However, instead of using super-heated steam as has been done heretofore for the same purpose, a film is first obtained in this process by galvano-plastic methods, this film only partially protecting the surface of the iron from oxidation. Upon subsequent heating, however, oxidation begins, but instead of the ordinary red oxide (sesquioxide) the magnetic oxide is produced. The first film volatilizes under the heat, while the magnetic oxide completely covers the surface. How successful this process has proved or may prove we are not in position to say at present.

A Curious Phenomenon in the Fusion of Mild Steel was described in a paper read by Mr. Carulla at a recent meeting of the Iron and Steel Institute, which is, that the interior of a piece of mild steel may be raised to the fusing point while the outside remains solid. In explanation of this phenomenon, Mr. Carulla says that the melting point of the interior of a mass of such steel is lower than that of the exterior, and this is probably caused by the concentration in the interior portions of the ingot that remain fluid the longest, of carbon, sulphur, and silicon impurities. If this explanation be accepted as satisfactory, it supplies another reason why the turning, planing or shaping of forged pieces of machinery weakens them in a larger ratio than the amount of material removed has to the mass of the forging.

The Chicago Exposition will, it is announced, be made the subject of a series of lectures, illustrated by a stereopticon to be delivered before various associations of manufacturers and art societies, throughout the United Kingdom by Mr. James Dredge, the accomplished editor of *Engineering* (London), who, as one of the British commissioners, recently visited Chicago in the interest of the projected English exhibits. There can be no doubt that in addition to the great interest these lectures will themselves have in a literary point of view, they will also greatly intensify the interest in the exhibition itself on the part of the English public.

A New Process for Protecting Iron and Steel by coating them with lead has been recently introduced in England, the close adherence of the lead being attained by very thoroughly cleaning the plates, and the use of special fluxes. It is said that sheets coated with lead by this process may be bent or corrugated without the slightest injury to the coating or any perceptible detachment of it, and that the process is applicable not only to plates, but to wire. Whether this can compete with the use of zinc for galvanizing iron plates remains to be demonstrated.

POPULAR MISCELLANY.

OF Rain Making we have at last something reliable, being a report from the meteorologist, Mr. George Edward Curtis, of the Smithsonian Institution, who pronounces the whole series of experiments as both a practical and a commercial failure, entirely contrary to the rose-colored statements which have been made from time to time through the daily press. He states that during three weeks of the time with which he was connected with the expedition, only two-tenths of an inch of rain fell. One one occasion a slight fall of rain followed a discharge of rackarock, and a small shower followed a number of hours after another similar discharge; but he regards this as having no connection whatever with the explosion, as there were similar showers falling in different parts of the State that afternoon. It appears, however, that the profession of rain-making has been adopted by several adventurers, and that hereafter it will take place with the manipulation of the divining-rod and the business of the *oil-smeller*. As some of our readers not familiar with the tricks and manners of the oil-regions may need to be informed what the word "*oil-smeller*" means we will explain that an oil-smeller is a man who professes to discover the existence of oil beneath the surface of the earth by the sense of smell. It is needless to say to the intelligent readers of this magazine that he is a charlatan, and that the professional rain-makers, in so far as any of them know anything about producing rain in the present state of science, are charlatans. Gen. Dyrenforth appears to be anxious to relieve himself from any such implication as this by declaring in the columns of the New York *World* that he is not a rain-maker, and declining to perform (at the *World's* expense) experiments proposed by that enterprising daily to be carried out in the Croton watershed that supplies New York City with water and has recently afforded a very short supply.

The Laboratory of Professor Pictet at Berlin is interesting in connection with the above. Nearly every one acquainted with the subject of artificial refrigeration will recognize the name of this eminent scientist as the inventor of what is called the Pictet Ice-Machine in which anhydrous sulphur dioxide is the refrigerating agent. He is also the first who reduced hydrogen and oxygen to a liquid state. Many of our readers will not need to be informed that Professor Crookes, the celebrated English scientist, has made himself famous by experimenting upon matter in the highest degree of attenuation, and has discovered that in this state it exhibits properties widely different from those pertaining to either solids, liquids or gases, as we know gases in ordinary experience. These experiments of Professor Crookes are among the most brilliant of the present brilliant age. Not less noticeable are those which are being carried out by Professor Pictet in his Berlin Laboratory. He has, so to speak, "taken hold of the opposite end of the stick," and is dealing with gases in their most condensed state, which, as will be inferred, is frequently that of a liquid. To obtain these conditions of gaseous matter, not only enormous pressure but intense cold is required. Temperatures of even as low as 200° Centigrade are obtained by him through the method of using the refrigerating power of one of his machines to cool the liquid produced by another, the temperature of the expanding liquid being thus reduced within the final limit almost to any extent. He is making some very interesting scientific discoveries, among which one is of eminently practical value. The writer of this paragraph once superintended the erection of the Allen Dense-Air Ice-Machine for chemical purposes, in which a temperature of 60° below the Fahrenheit zero was guaranteed to be maintained in methylic alcohol, contained in a tank surrounded by an insulation

of saw-dust some 18 inches in thickness. It was found in the attempt to maintain the guaranteed low temperature in the tank that the apparatus reached its limit of low temperature considerably sooner than it should have done theoretically. At the time no explanation of this then curious phenomenon could be offered. Professor Pictet, however, has discovered what appears to be a sufficient cause for the phenomenon, in the fact that material hitherto considered a nonconductor of heat seems to lose its nonconducting power below certain temperatures. The principle is announced in Professor Pictet's own language as follows: "The slow oscillations of matter, which constitute the lowest degrees of heat, pass more readily through the obstruction of a so-called nonconductor, than those corresponding to a higher temperature. just as the less intense undulations of red light are better able to penetrate clouds of dust or vapor than those of blue." If this principle be accepted as true, there can be but one conclusion as regards the limit of low temperature that can be reached ; it will be impossible to lower temperatures beyond about 255 C.

"The Physical Properties of Gases," by Arthur L. Kimball, from the Riverside Press, Cambridge, is timely, as there are few scientific subjects upon which there is a greater popular lack of sound information. By sound information is not meant that profound insight into the relations of pressure, temperature and volume, only to be gained by the reading of exhaustive treatises upon thermodynamics; but the more obvious properties which underlie familiar everyday phenomena. It is, indeed, doubtful, whether one in a hundred people of average education, ever dreamed that the property of viscosity is met with as a physical property of a gas; most of them probably associating this characteristic of the solid, liquid and gaseous states of matter only with substances, resembling glue, tar or molasses. How many know that nearly all gases are liquefiable under the action of cold and pressure—a property which is the basis of the most powerful ice-machines now in use? The chapter in this book describing the experiments of Cailletet, and of Pictet upon the liquefaction of gases is a record of some of the most remarkable and ingenious experiments in the history of physical science; and, like the rest of the work, is presented in a manner intelligible to readers who have not enjoyed opportunities for technical training. One adverse criticism must be made. The book is without an index, and its meagre table of contents illy supplies this deficiency.

Some Extraordinary Lumber is described in the Philadelphia *Press* by a gentleman who has recently visited the North Pacific Ocean. He says that boards 100 feet long and 6 feet wide, without a knot in them, are common cuts from the gigantic fir trees of the Puget Sound forests which grow to a height of 250 feet. This appears to be a statement which should be accepted with some caution, although we do not mean to say that it is exaggerated. The use to which boards 100 feet long and 6 feet in width can be put will be, however, a matter of speculation to practical men; and what advantage could be obtained in having boards of this enormous length and width, which must be so enormously more difficult to handle than those of practicable size, will also be a question which will seek a practical answer. There is no doubt about the vastness of the timber growth in and around Puget Sound, but this statement, which has been copied into numerous other publications, has about it something fishy. We have no doubt that some of the fir trees could produce boards 100 feet long and 6 feet wide, without a knot in them, and that possibly some such boards have been cut as matters of curiosity; but that piles of this kind of lumber are common, as has been asserted, we hesitate to believe.

An Interesting Occasion was the unveiling ceremony of the monument at Bordentown, on the 12th of November, in commemoration of the like date in 1831, at which time the first locomotive service in the State of New Jersey was initiated. The locomotive "John Bull" was the first one employed in this service and the old en-

gineer, Mr. Isaac Dripps, who ran it on the date commemorated, now lives in Philadelphia, being 82 years old. The monument was erected by the Pennsylvania Railroad, to-day the largest railroad enterprise existing in the States of Pennsylvania and New Jersey; many prominent men were invited and appropriate addresses made. Some of the old granite blocks used as sleepers were employed in the construction of the base of the monument and around the monument is wound one of the original rails held in place by the original spikes.

The Commendation of American Mechanics, extended to them by various eminent English mechanicians that have visited the United States, is thought by the *Mechanical World* (London) as exaggerated. Particularly are the reports made by the members of the Iron and Steel Institute made the subject of criticism, as is also a paper recently read before the Manchester Association of Engineers by one of the members of the Iron and Steel Institute who has recently visited this country. The *Mechanical World* appears to think that the views of the author of the paper have been derived chiefly by an inspection of the shops of Messrs. Brown and Sharpe, as his remarks were practically confined to a description of that establishment. While the *Mechanical World* admits that everything in this shop is done "to facilitate the production of first-class work and to secure the comfort of employés," it thinks that "it is hardly fair to assume that the artisans there employed are representative specimens of the American mechanic." If the writer of the editorial under consideration intends to differentiate American mechanics from foreign in the sense of *native* American, we must differ from him in the opinion expressed. We do not think that the mechanics in Brown and Sharpe's establishment average any better than *native* American mechanics elsewhere; but it is true that we have imported a great many mechanics from abroad who do not average as high as American mechanics in their efficiency. The article goes on to state as a matter of fact "that it is at present possible for an English machinist to take a contract for the whole of the machines in an American mill, inclusive of freight charges, duty, men to superintend erections, etc., at a lower cost than the American gentleman next door who has the advantage of such immeasurably superior tools and such wonderful workmen;" and it attributes the impression which English visitors obtain to our "national vanity and love of 'tall talk.'" With due respect to our English contemporary's opinion we would suggest that the production of cotton-manufacturing machinery does not represent the highest type of mechanical skill, and that the difference in wages paid in England to workmen to make this class of machinery, as compared with the prices paid to skilled workmen in this country, sufficiently accounts for the successful competition of the English producer.

Communication with Other Planets seems to be an impracticable dream; yet, in view of the enormous advances which science has made during the last fifty years, it may become practicable in the future. Mr. Hiram M. Stanley in a letter to *Science* describes a method which he thinks may some time succeed and which he thinks worthy of mention. His idea is that "on a moonless clear night the electric and gas lights over such a large territory as New York and its suburbs must present the appearance to a spectator in Mars of a spot of light on the dark side of our globe. "If, now, on such a night, from the middle of some large dark area, for example, the Atlantic Ocean, brilliant flashes of light be regularly sent forth in certain forms, there would be a chance of its being interpreted by the inhabitants of other spheres, and they might thereby be induced to signal us in return." Another method suggested by him is the projection of bodies from the earth to other planets. He calculates that an initial velocity of seven miles a second would project a body beyond the earth's attraction, by which he probably means that it would project it to a distance at which the attraction of other bodies would over-master that of the earth, and the body projected would thus be drawn to

one or another of the planets in our system. He thinks it is not too much to hope that an initial velocity of this magnitude will soon be attainable, at the present rate of progress in the science of explosives.

Another Scheme for Signalling the planet Mars is discussed in the *Mechanical News* by Mr. S. P. Adams. He regards it as entirely feasible, that is to say, assuming that Mars is inhabited by intelligent minds sufficiently evolved to appreciate the significance of geometrical diagrams. The method proposed is to mark out, on an immense scale, on the Desert of Sahara, a right-angled triangle. It is expected that this will be responded to by the mathematicians of the sister planet by the immediate erection upon the sides of a similar triangle, drawn on some favorable plain, of the three squares corresponding to the celebrated Pythagorean figure accompanying the demonstration that the sum of the squares of the base and altitude of a right-angled triangle is equal to the square of the hypothenuse.

Modern Education is Discussed as a Failure by Mr. Frederic Harrison in *The Forum* for December. A single sentence in this able criticism is worthy to be engraved upon the memory of all educators: "*A uniform system of education is a form of madness akin to a project for making men of one size or one weight.*" Mr. Harrison asserts that after forty years or so, he is "coming round to think that the less we systematize education, dogmatize about it, even talk about it, the better. A good education is a general mental and moral condition like a virtuous nature, and a healthy body, and we are all treating it as if it were a special art or a technical craft and could be taught like playing the violin, or tested like jumping." The article condemns wholesale the "fundamental sin of apportioning out education to 'gentlemen' and to tradesmen and to artisans in the 'public school,' the commercial 'academy' and the 'board school'" as increasing all kinds of evils. We commend these wholesome words to the consideration of the Boards of Education in American cities. The writer of this paragraph early adopted teaching as a profession, abandoning it later on simply because he could not adjust himself, to, or so far renounce his own personalty as to work in, the modern grooves marked out by ingenious *machine educators*. Few able thinkers can study the school systems now in vogue in most of our American cities without coming to the conclusion that they are failures. It is true, that from them occasionally issue pupils who make their mark in future life, but these are exceptional, and would make their mark just as surely had they never seen the inside of a public school. Any system of instruction which compels the teacher to subordinate his own personality to the dictation of another, in other words, *to teach by rule*, must of necessity be a failure. The same number of *The Forum* contains an article coming from Dr. J. M. Rice, who places as the title to his essay the significant question, "Need School be a Blight to Child-Life?" In this article he describes his experience in German schools and compares them with those in New York. No one can read this article without pitying the less fortunate children of American cities. In the German schools, teaching pursues a natural course, is conducted by thoroughly well trained teachers with full liberty to throw their whole personality into their work and interest the minds of pupils by any methods which may be extemporized for the purpose, as the spirit moves them; whereas, as Dr. Rice truly charges, the teaching in the New York schools is "mechanical," the teachers (exclusive of the principals) are "practically untrained," and the course of study is so arranged that instead of beginning "with the concrete they begin with the abstract." In these two articles is opened an attack upon present methods of education which we trust will be followed up by such influential publications as *The Forum* until a thorough reform is secured.

A Very Attractive Exhibit will be made at the World's Fair by the De Beers Consolidated Mines Company. This is to be an exhibition of diamonds from Cape Colony, together with an exhibition of all the various processes which fit native gems for the jewelers' art as well as the methods by which the diamonds are mined.

MACHINE-SHOP NOTES.

By Col. Loquial, M. E.

SHAPLEY had a leading shaft that he had been trying for about ten years to convince himself was heavy enough for the power which he had been putting through it; and after all these years of wabbling about from one side of the question to the other, he came to the conclusion that it must go. So he ripped out the three-inch shaft and put in a four. It cost him considerable money, and took a good deal of time; and of course the earnings of the shop during that time very much lessened; and after all that, fancy his feelings when one of his sons came back from college and said to him: "Why father, that's rather a fool job you have been paying for. Why didn't you just turn the old line around a little faster and alter the pulleys at each end? You don't take any power off the line between the ends, and as it is, both the old shaft and the new one have been speeded too slow for the machinery at the end farthest from the engine." Shapley feels something like the man who had been winding up a clock every day for twenty years and then found out that it was a twenty-eight-day clock; but perhaps there are more Shapleys in this great country of ours.

* * *

If some one were to put a heavy eccentric on one of your shafts and let it hang with one big side and one little one, you would not like the effect that it produced; you would complain that the motion was wearing on one side of the shaft and that it made the machinery run unevenly. But while you may not have anything that sticks out farther on one side than on the other in the way of an eccentric, you have on your shaft there a pulley that is jarring things and wearing the journals on one side; a big pulley that is very much out of balance. I suppose that somebody when he put up that pulley, or before he put it up, gave it what is mis-called "standing balance;" which is about the kind of a balance that the tight-rope walker has when he is lying in bed sleeping—a very safe balance under the circumstances, but not worth a continental for purposes of tight-rope walking. Standing balance is of no more use to a running pulley than a life-preserver in some one's store on Broadway would be to a man who fell overboard in mid-ocean.

But if I had a dollar for every pulley running in this country—or even the city of New York—on standing balance only, I should be rich enough to make some very decent Christmas presents. What a pulley wants—or rather needs—is running balance; it should be tested when it is running, first in a vertical axis or cock-head, then in the position in which it is to run, and at the speed at which it is to run. Then if it has any eccentricities of size or weight they will develop and may be corrected before the pulley is put to work springing shafts and shaking buildings.

* * *

"Why have I got that engine and dynamo raised so from above the floor?" Well, if you will ask that belt you will get an answer about as quickly as if you ask me. The first dynamos that were put up in New York were set on the floor, and were driven by engines that had their bed-plates flush with the floor also. There were small pulleys on the dynamos and small driving-wheels on the engines; and the result was that every now and then the belts broke with the tension that was required to get the machines to turn steadily. Now raising both the engines and the dynamos from the floor enables larger pulleys to be put on each, and furthermore lets the belts be run very much slacker than where there would be danger of their touching the floor. A raise of two feet in the height of the machine enables the use of a pulley that is two feet greater in

diameter, that is, more than double what they used to put on—and still enables the belt to be run slacker than formerly. All that you have to do is to keep the lower flap of the belt from touching the floor when the machine is running, and you have the best conditions of driving that can be had under the circumstances without an idler to increase the belt wrap.

* * *

I see that you have only one grindstone about your shop, for every class of tool—large and small, wood-working and iron-working. If you will only reflect a moment you will find that it will be to your advantage to have a harder stone for your planer-tools and for every tool that is to work iron or steel than for those which have to cut only wood—and soft wood at that, such as I see that you use principally in your pattern shop. I note, too, that your man there is holding his tool so that the stone rotates from him. As the stone is in tolerable balance, he is wrong. So long as the stone is true it should be run towards the tool that is being ground—that is, of course, assuming that the tool is held on the upper side, and with its cutting-edge inclined upwards.

* * *

About as simple a method of jacketing steam-pipes as has ever been tried successfully, is one which was got up in Germany. It is a very simple trick—where pipes are flanged. Strips of iron about six inches longer than the distance between flanges are bent over at right angles at about three inches from each end; wooden strips are screwed to these iron ones; the turned-over ends of the iron strips are pinched between the flanges so that the strips stand for about two inches from the pipe on all sides; then ordinary stout wrapping-paper is wound around the wooden strips so as to make a continuous envelope except for about three inches at each end, where felt is stuffed in. In one shop such a covering has lasted over thirteen years without failure or renewal; and as it is very light it is especially adapted for large horizontal pipes.

* * *

I should think that your foreman would see, every time that he went over on that side of the shop, that you have benchmen who are working at a disadvantage in having their vises too high. Watch that man as he works. The top of his vise is higher than his elbow joint as he stands at the bench; every time he makes a forward stroke he has to raise his whole arm, including his shoulder; and even then he doesn't make a straight horizontal stroke. Now if you will lower that vise about two inches, or give the man a platform to stand on, you will enable him to do more work, and better work, with greater comfort, than at present. As the workman's elbow will average between 40 and 44 inches from the floor, you may say that 42 is the proper average. Fine, light work will permit of a higher vise than coarse heavy jobs. These are little things, a few hundreds of which make up the difference between good and bad work about a shop, or between success in general and mediocrity.

* * *

Balance is the thing in handling those big castings. Here you are straining everything and everybody, because nearly every one that you have slung is so hung that it will only hang one way, and in addition that it hangs lower than it should to be conveniently handled, requiring you to lift it higher than if you were to sling it differently. Now in raising Cleopatra's needle, which is somewhat of a massive stone, the engineers calculated its center of gravity so nicely, that when they got on its iron jacket and raised it by its trunnions, it balanced so exactly that one man could cause the entire great mass of 200 tons to swing. Don't you suppose that that enabled them to handle it more easily than if it had been picked up about five feet to one side of its center of gravity, so as to have a long end tipping down and leaning against everything in the way?

* * *

I don't like to see a man spend about four dollars' worth of time and forty cents' worth of tools, in correcting work that should have been right at first. Now, for instance, there is a man who is using a round file to correct a hole that did not come fair in boring. It will take him about

a day and a half to go over that particular job; he will use about forty cents' worth of files as I figure it. After he has got through he will only have a round hole, which he should have had at first; and it will not be of the diameter that was desired, but will be too large. If he had properly used the tools and jigs that are at his disposal he would have saved you the cost of his time and files, and himself the mortification (if he feels it) of having done a bad job; although what usually causes the mortification is not doing bad work but being found out. He should no more use labor and round files to correct work in his department, than his fellow workmen should use a drift to correct bad punching in the boiler-shop. If your man will start out and mark off two circles, one of the proper size and the other half the size of the hole to be drilled, he will find out when he has got down to the size of the smaller circle, whether he has made his start right or not; and if he has not, he can readily correct himself before he has gone far enough to do any harm; but if he waits until he gets to the full diameter of the hole, it will be too late.

* * *

Over in England a New York mechanic who has established a big shop near Manchester has got up a new way of keying pulleys and such things on shafts. Instead of making a shallow groove in the shaft, parallel with its length, and one in the pulley hub to correspond, and putting in a key that runs lengthwise of the shaft, he cotters deeply into the shaft, making a narrow groove with rounded ends, that runs lengthwise of the shaft; and making a similar deep cotter cut through the hub, he puts in a flat steel key with rounded edges at right angles to the shaft. He has a machine which makes such cotter grooves of several standard sizes, and another machine which makes the keys of standard sections and cuts them off to convenient lengths; so that all that is required to do is to mark on the drawings "No. 5 Key," or whatever size it is, then the work of cottering can be done without any special instructions, and the key can be taken out of stock in the same manner as wire nails are.

Now that you have one of the ordinary keys, running lengthwise of the shaft, and which gives you trouble in getting it out, you may as well have some way of getting it out when you want to take off the wheel. You can get this by having a bayonet offset on the outer end of the key; threading this offset parallel with the shaft, and having a nut which you can screw on the threaded end, until it jams on the end of the shaft after which, running on the nut will gradually draw the key.

* * *

Some of those rails are longer than the others; and the reason of it is that while the gages were set all right, some of the rails were hotter than the others; and those which were the hottest when cut are the shortest when cold, having contracted more than the others, after cutting. In some of the German mills they never have any such trouble; they look at the rail through a dark glass, through which, when they have cooled to a certain temperature, they cannot be seen at all. A dark blue or an orange yellow glass will make a red-hot rail invisible. It may be considered a fact that any two rails looked at through the same pair of glasses will disappear at the same temperature. If every rail is allowed to cool until it is just invisible through a certain pair of glasses, all will be of the same temperature; and their lengths will be the same.

This is one of the lessons that we may learn from our cousins across the water.

* * *

I see a good wrinkle being used by an Italian in Paris, in the way of enlarging patterns for busts, etc. There is a small head of somebody or other; whether it is of Peter Cooper or St. Peter makes very little difference; it is desired to make a colossal copy of it, for use in a bronze foundry. It is marked off into horizontal planes of equal distance apart; and also into radial vertical planes axial with its central line; then the distances are calipered and transferred to a honeycomb frame built up of thin boards arranged in planes which are symmetrical with the markings on the original. By cutting into these boards to the required distances you

soon have a skeleton which corresponds in outline with the original. The spaces between the thin boards are filled up with plaster or other material, and there you have the enlarged copy made in a very cheap, accurate and practical way.

* * *

I don't suppose that any one could give a treatise on the art of iron-founding, in ten minutes; but in ten minutes the entire principle of successful castings may be stated. For instance, there your man is making a mold in which he is going to put the runner in a thin part instead of a thick; a big "don't" would be of use to him if he would heed it. Then he is going to run the metal in at the top, although it is a deep casting. The man next but one to him is going to run that flanged pipe at a point in the length of the pipe instead of at the flange; and I see that that long thin branched piece has been run at one end instead of from the center.

It has not taken me two minutes to point out three or four very grave faults in your foundry practice, from actual observation of bad work; and I believe that by going about and seeing bad work in other foundries it would not take me long to get up rules which would not require ten minutes to pronounce, but which would enable good work to be done if the men would only pay attention to them and use their knowledge boxes more than their tobacco boxes.

* * *

Sykes has just put a shaft in a lathe without drilling and countersinking the centers; and the result is that he is doing work which is a trifle out of true, and at the same time he is enlarging the lathe centers and making it less possible for him to do correct work on other jobs which follow. It is about the same way all over his shop; and the result is that it takes a man who has run any tool in his place to get any sort of work out of that tool. A new man coming in would appear to be a botch although he had come from a good place in one of the best shops in the country; while an old moss-back who knows how to humor Sykes' lathes and things will get creditable work out of them.

Ballard goes to the other extreme; he puts about a three-quarter inch hole in the end of a two-inch shaft.

* * *

How to straighten that shaft—it is not a difficult matter if you set about it right. That means center it properly, having prick-punched it and drilled or reamed it properly; and work the square center well while the shaft is turned as fast as you can. Then a screw press which traverses the lathe body is applied; and it should have wedge blocks that may be made nearly together or further apart at will, and should have V's on the top, that can be raised. If the crook is long, the wedge blocks are moved further apart; if it is short, then they should be closer together. Turn the shaft, and as it turns mark it with chalk every three or four inches all along; then the screw press may be brought into operation. After it is made straight, it should be squared true with a side tool; then the centers reamed again with the square center and drilled about an eighth of an inch deep with a small drill.

* * *

The way that Lee figured up the number of teeth for a wheel which he needed to cut a screw of one-and-half-inch pitch with a compound-geared lathe was not by figuring, because every one who figured on the job told him a different number; but he put on the gear to cut one inch pitch; took up all lost motion, marked the carriage and face plate, put a two-foot rule with one end on the floor and the other on the third change of wheels, made a scribe-mark above the rule, went to the face plate and moved it until the carriage had moved one-and-one-half inches on the bed, went back to the gearing, made a second scribe-mark on the same wheel, and noted the number of teeth in the wheel between the scribe-marks. Then he told the foreman that he must have a wheel made, with twenty-five teeth instead of twenty-eight. It was ordered and made, and when put in place made the worm with one-and-one-half inches pitch.

All of which shows that there is more than one way of killing a cat besides choking it with butter.

COMMENT & CRITICISM.

THE commendable rule is observed by the Smithsonian Institution of not attempting any work which may be accomplished as well or better by other existing agencies. Even when a line of work has been inaugurated by the Smithsonian, and it becomes apparent that it may be performed equally well through some new channel, it has been the practice to surrender this work that the Institution's income may be devoted to original research in some field not otherwise covered. Thus the meteorological observations which had long been made at the expense of the Smithson bequest ceased upon the organization of the Signal Service and the records pertaining to them were placed at the disposal of the War Department.

The criticism of the work of the United States Engineer Corps contributed to this number of THE ENGINEERING MAGAZINE by a gentleman formerly connected in a professional capacity with the work of the Corps suggests the inquiry whether the time has not arrived for the Government to adopt a new policy in relation to the engineering on public works demanded by the commercial interests of the country. The purpose of the Federal Constitution was to unite the weak and struggling American States for their commercial advantage. In order that the political family thus formed might not be disrupted by jealousies, the regulation of commerce among the States was delegated to Congress, which body was soon appealed to for the development of the water-courses and harbors—then the chief means of inter-State transportation. This work being deemed for "the general welfare," payment for it from the public treasury was readily assented to. In time there came into existence a corps of trained engineers, depending upon the Government for support while awaiting military emergencies, and not unnaturally they were placed in charge of the public works. It is not necessary now to question the wisdom of this course at the time of its adoption, but only to consider whether the reform of the admitted abuses which have grown up in the public-works service will not require a complete change of system.

Certain conditions which did not exist in the beginning may now be taken into consideration. Capital for public works could then be raised only by pledging the public credit, just as the first railways and turnpike-roads had to be built by State and county taxation; now private capital exists in abundance for any undertaking justified by commercial necessities. Formerly the number of competent engineers was small, whereas the supply from the ranks of private life is now practically unlimited. Finally, the ordering of public works, being left to the judgment of Congress—an immense, unwieldy and often uninformed body—is becoming a matter of accident or chance, more liable to be a bribe for votes in the Congress districts than an answer to the real wants of the commerce of the country.

In the suggestion of steps toward the reform of this system a wide field is open to our engineers, statesmen, and intelligent men generally. Some idea of the importance of the matter may be gained from the statement, in a Government publication, that the amount paid from the public treasury for river and harbor work from the beginning of the Government to March 3, 1887, was $157,512,852.17. Subsequent appropriations have amounted to several millions more. If it be true, as claimed by Mr. Wisner, that much of this money is wasted, the study of new methods of securing needed public engineering works is worthy of the attention of the best minds.

Aerial Navigation by Bird Teams.

I HAVE just read, with great interest, an article in your October magazine entitled "Progress in Aerial Navigation," written by Mr. Octave Chanute. Several years

ago I gave some thought to this subject, and it often occurred to me that a successful result could be obtained by other means than that then and now proposed, for all seemed based on the same line of reasoning.

We harness all kinds of animals to vehicles here on earth, then why is it not feasible to harness some of the larger fowls of the air to an aerial car and make them do duty other than to grace our tables or spin, according to their own will, through space?

This may not conform to scientific theories, but I cannot but believe that more force will be gotten in that way than by your wind-wheels. It would do away with the extra weight of machinery, etc., necessary to the movement of the car, as now proposed.

Of course it would require trained birds. Say, for instance, the "Canada goose"; he is a swift flyer and would, no doubt, answer the purpose. Half a dozen of these birds, or any other that might answer, could be properly arranged to push or pull the car. CHARLES SWEET.

New Orleans, La., November 9, 1891.

[It would hardly seem that the idea proposed by Mr. Sweet can be considered new in view of the fact that the fair goddess Cytherea is stated, upon what was once received as orthodox authority, to have produced a sensation among the elite of ancient mythology with her stunning turnout of milk-white doves, as she aired herself afternoons on the divine boulevards, herself dressed in the elaborate costume of the period, holding the reins. But, joking aside, there is neither scientific, nor any apparent practical reason, why the example of the goddess should not be imitated in modern times for utilitarian purposes, instead of for the mere gratification of female vanity, unless, perhaps, a goose might prove more intractable to train than a horse, an ox or an ass, a goat or a dog. A Canadian goose, turned out to pasture, might be difficult to catch when wanted. Some difficulty might be experienced in the establishment of aerial stations at which ornithic teams could be stabled, groomed and fed, with suitable accommodations for the simultaneous rest and refreshment of passengers travelling by such superterrene stage-lines. These are not cited as insurmountable difficulties in this age of multitudinous material resources, but as samples of some of the things that must be provided for. The out-door, unrestrained pasturage of Canadian geese and other large strong-flying birds appears a probable necessity, as most of our domesticated fowls have, through the very fact of domestication, largely lost the use of their wings.—EDITOR.]

Geology From a Business Point of View.

THE article by Professor Williams in the December ENGINEERING MAGAZINE reminds me of one instance where a State Geologist brought wealth to people who did not deserve it by virtue of industry or intelligence. I refer to the matter of the marl-beds in New Jersey. There was a class of take-it-easy farmers in the lower end of Jersey satisfied to earn about $400 a year and save $375 of that. One lucky day the State Geologist came along and found marl on their farms; and some bright man, by constant dinning upon the farmers and their neighbors, succeeded in getting them to try it as a fertilizer. It was found to be a success, particularly on moist land, and some of the moist land was in the neighborhood of the marl itself. So people began to buy and use marl; and the marl-beds of Pemberton and other parts of New Jersey became mines of wealth to their owners and causes of wealth to their customers. There was one old fellow who, by reason of the discovery of marl upon his so-called farm, got rich without working; and he had the only "snap," except one, that I ever wanted. The marl-bed was back of his house, and there was a road along each side of the house, down to the pit or bank of the green treasury. The neighbors used to drive in with two-horse teams, load the wagons at the marl banks, and drive out, paying a royalty of fifty cents per load for the privilege. All that this old fellow had to do was to sit on the porch of his house in an arm-chair, with his hat on the edge of the

porch alongside of the chair; every man who drove out with a load of marl had to drop a fifty-cent piece into that old hat; and all that he had to do was to see that no one got out without dropping fifty cents into that hat. As business increased there got to be a pretty steady stream of loaded wagons going out, and of fifty-cent pieces dropping with a merry clink into that old hat—for prosperity never induced him to get another hat, even when the old one got bunged out of shape with the weight and the impetus of the half dollars. That man grew rich in spite of himself and he owes it to the State Geologist. Why I suppose that even in dreams neither he nor any one else ever thought of paying the State Geologist a royalty on the marl that he discovered on the old Jerseyman's farm.

ROBERT GRIMSHAW.

A Plea for Better Text-Books.

IT is of prime importance that every writer of a scientific text-book should consult the needs of his class of readers, and strive, by judicious and logical arrangement and treatment of the subject-matter, to supply these needs in the most advantageous manner. Unfortunately, the great majority of the so-called text-books on engineering are so highly abstruse and theoretical, or so distorted by illogical treatment, that they are worth little except to the experienced engineer. In our text-books very little attention is ever paid to the methods of maintaining or repairing engineering works, when in reality the economy of maintenance and repair is, and must always be, of great importance to the engineer. I know of no book which treats to any extent, or at all satisfactorily, the subject of railroad repairing or the methods of erecting temporary railroad structures in case of accident.

We want more practical information in our text-books. Engineering is essentially a practical science, and practice *should* always occupy a first place in the books designed for the use of students of engineering; but, unhappily, it *does* not. There are in our colleges great numbers of engineering text-books, crammed full of nothing but theories, through which the student manages to drag through by dint of hard labor, and in the end he is but little better off than before, because he has never been taught to reduce these theories to practice.

Conciseness, perspicuity and practicability are qualities which should be possessed by every work on engineering, and especially so by every text-book. Our authors are rarely as concise as the needs of the student require; perhaps they take it for granted that the student knows many things which he does not know, and consequently their work is inapplicable to the student of no experience, while it may be very satisfactory to the experienced engineer. In some instances I have noticed that the author makes a statement, and almost immediately refutes it by another statement. This occurs frequently in reports of tests, widely different results being obtained under different machines and at different places. The student is then at loss as to which result to take as the most trustworthy.

Our authors generally put down the dry facts and let students take them as they may, when their value could be enhanced a hundred-fold by the comments of the author, thus giving the student something definite to fall back on.

Although conciseness and perspicuity are very valuable qualities, practicability is without doubt the most needful, for what is the value of any science unless it can be reduced to the ordinary affairs of life? Cases are arising continually in practice for which no provision is made in the text-books. Although we cannot expect the literary abilities of our great engineers to be of the first-class, (because a man is rarely great in all things), we have a right to expect better style than we get.

W. E. WOODWARD.

Charleston, S. C., November 5, 1891.

Trees Destroyed by Electricity.

MR. SAMUEL WEBBER'S note on a group of elm-trees in Charlestown, N. H., apparently killed by electricity, the most of which showed no visible signs of having been struck except their sickening and dying after one of their fellows had been

shattered by a bolt, taken in connection with a paragraph in the Electrical department of THE ENGINEERING MAGAZINE for August describing the death of a large elm from lightning stroke, suggests that elms may be more susceptible to vital injury from lightning than other trees.

I think the existence or non-existence of such a special susceptibility, if either could be established, would be a point of great interest as well as some value, not only to the art of landscape gardening, but to the science of physiological botany. Fortunately information confirmatory or otherwise seems easy to get, if those who have observed the death of trees apparently from lightning stroke would kindly imitate Mr. Webber's example and state all the facts attending such phenomena that have come under their observation.

LEICESTER ALLEN.

Rain-Water for Domestic Use.

AMONG the articles in THE ENGINEERING MAGAZINE for December there is nothing more opportune than the one entitled "Impure Water and Public Health." Dr. Davis touches lightly upon the subject of rain-water as a supply. In this country, where rain is quite a regular thing at all seasons of the year, filtered rain-water should be adopted universally as a permanent source of supply. With modern house-plumbing and the perfection of domestic fixtures, it seems a great omission not to use it more generally, since for purity and excellence it is unexcelled for most purposes. The adoption of cisterns with filters would give some good water in localities where at present it is scarce. The building of water-works and sewers during the last few years has been remarkably rapid. This fact is making the subject of river pollution from sewage an important one, and one which demands speedy attention. The creeks and rivers are yet in virgin purity and sylvan beauty, but the next twenty years will either improve or degrade them to the grade of foul water drains. Filtering and sewage purification must soon be introduced to save the streams. W. CLAYPOOLE.

Springfield, Ohio, December 12, 1891.

The Minnesota World's Fair Fund.

IN the December number of THE ENGINEERING MAGAZINE I notice a statement in regard to the Minnesota World's Fair fund, which is inaccurate. It is stated in the department of "Popular Miscellany" that "to this end an address has been made to the several counties in the State, *which by the original enactment were required to furnish each their proportion to the fund*, urging them to increase their several proportions in order to *increase the fund to $100,000.*" The italicised portions are incorrect. The original appropriation was $50,000, to be paid from the State treasury. No part of this fund could be used for a building, and as a building was deemed necessary, the commissioners called upon the counties in the State to raise an additional $100,000, paying in proportion to their assessed valuations. The superintendent informs me that twenty-eight of the eighty counties in the State have responded already to this call, and that there is no doubt but that the additional $100,000 will be easily secured, making the State's fund $150,000. Your periodical is of such a high class and is read with so much interest that an error, however unimportant, is to be regretted, and I have taken the liberty of calling your attention to this matter.

GEORGE H. SARGENT,
Assistant City Editor, St. Paul *Pioneer-Press.*

A Correction.

IN my article on the Canadian Pacific Railway in the December ENGINEERING MAGAZINE there is a type-setter's error on the first page making me write of the "International" Railway instead of the "Intercolonial."

T. KENNARD THOMSON.

EDITOR'S EXCHANGE TABLE.

AN INDEX TO CURRENT TECHNICAL LITERATURE.

THE tabulated list contains the names of exchanges most frequently quoted. To save space the abbreviations respectively prefixed are employed in the list of articles following the index. Illustrated articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of publications mentioned should be sent direct to the addresses given.

A A.....American Architect. *w.* 15c. Boston.
A E .....Architectural Era. *m.* 25c. New York.
A & B ....Architecture and Building. *w.* 15c. New York.
A J R A..American Journal of Railway Appliances. *m.* 25c. New York.
A M.....American Machinist. *w.* 6c. New York.
B J C....Boston Journal of Commerce. *w.* 6c. Boston.
C A B ....Canadian Architect and Builder. *m.* 20c. Montreal.
C E .....Colliery Engineer. *m.* $2 per year. Scranton, Pa.
E E L ....Electrical Engineer. *w.* 3d. London.
E E N Y..Electrical Engineer. *w.* 10c. New York.
E L.....Electricity. *w.* 1d. London, Eng.
El.. .....Electrician. *w.* 4d. London, Eng.
E C .....Electricity. *w.* 7c. New York-Chicago.
E R L.....Electrical Review. *w.* 4d. London, Eng.
E R N Y...Electrical Review. *w.* 10c. New York.
E W.. .....Electrical World. *w.* $3 per year. New York.
E.....Engineering. *w.* 6d. London, Eng.
E M J.....Engineering and Mining Journal. *w.* 10c. New York.
E N.....Engineering News. *w.* 15c. New York.
I E.....Indian Engineering. *w.* As. 8. Calcutta.
I L. .....Industries. *w.* 6d. London, Eng.
I A.. .....Iron Age. *w.* 10c. New York.
I J M S...International Journal of Microscopy and Natural Science. *m.* 6d. London-New York.
Inv.....Invention. *w.* 6d. London, Eng.
J A E S...Journal of the Association of Engineering Societies. *m.* 30c. Chicago.
J O I.....Journal of Industry. *m.* 20c. San Francisco, Cal.
J F I .....Journal of the Franklin Institute. *m.* 50c. Philadelphia.
J N E W..Journal of the New England Waterworks Association. Quarterly. 75c. New London, Conn.
J S A.....Journal of the Society of Arts. *w.* 6d. London, Eng.
L E.....Locomotive Engineer. *m.* $1 per year. New York.
P A .....Progressive Age. *w.* $3 per year. New York.
P S.....Power-Steam. *m.* $1 per year. New York-Chicago.
P T.. ....Photographic Times. *w.* 15c. New York.
N .....Nature. *w.* 6d. London.
N B .. ...National Builder. *m.* 30c. New York-Chicago-St. Louis.
S A S.....Scientific American Supplement. *w.* 10c. New York.
Sc.....Science. *w.* 10c. New York.
S... .....Stone. *m.* 15c. Indianapolis, Ind.
R A E J..Railroad and Engineering Journal. *m.* 25c. New York.
R A.....Railway Age. *w.* 10c. Chicago.
R G.....Railroad Gazette. *w.* $4.20 per year. New York.
R M M...Railway Master Mechanic. *m.* $1. Chicago.
R R.....Railway Review. *w.* 10c. New York.
W E.....Western Electrician. *w.* 10c. Chicago.

ARCHITECTURE.

Old Colony Work of Virginia and Maryland *† (A A-Nov 28.)

Ancient Architecture for Students—Etruria and Rome—Chronological Notes. R. W. Gambier-Bousfield (A A-Nov 28.)

Architectural Training. A. C. Hutchison, R. C. A. (C A B-Nov.)

German Castles.*† Countess Von Krokow (A A-Dec 5.)

Architectural Shades and Shadows. A. D. F. Hamlin (A A-Dec 5.)

The Steel Skeleton Type of High Building. Corydon T. Purdy, C. E. (E N-Dec 5.)

Architecture and the Allied Arts. Barr Ferree* (The Inland Architect and News Record *m.* $3 a year. Chicago-De.c)

Concerning the Arizona Onyx. Geo. P. Merill (S-Dec.)

The Management of an Architect's Office (A A-Dec 19.)

Italian Specialties in Decoration and the Industrial Arts† (A A-Dec 19.)

CAR-BUILDING.

Steel Car Axles.† P. Kreuzpointner (I A-Nov 26.)

Sections and Mechanical Conditions of Car Wheels. P. H. Griffin (R R-Dec.)

CHEMISTRY.

Notes on Allotropic Silver. Relations of the Yellow to Blue Forms. M. Carey Lea (P T-Nov 27.)

Iron Carbonyl from Water Gas. A. E. Tuton (N-Nov 12.)

The Iodation of *p*-Bromobenzoic Acid. Salts of *p*-Bromo *m*-Nitrobenzoic Acid. Oliver Hough (J F I-Dec.)

The Oxidation of Metallic Arsenides by the Electric Current. Lee K. Frankle (J F I-Dec.)

The Manufacture of Nitro-Cellulose. Dr. J. B. Littlewood (S A S-Dec 5.)

Chemistry Relating to Mine Ventilation (C E-Dec.)

Modern Advances in Chemistry. Prof. F. W. Clarke (The Crank *m*. 25c. Ithaca, N Y-Dec.)

Further Researches upon Azoimide. (N-Dec 10.)

CIVIL ENGINEERING.

Proposed Elevated Boulevard for Chicago. The Day System. St. John V. Day (Railway Age *w*. 10c. Chicago-Nov 27.)

Portland Cement and Concrete (E-Nov 27.)

Economy in the Use of Ballast in the Construction of Railways (R A-Sep 4.)

Some Criticisms of the Forth Bridge.* Gustave Lindenthal. Reply by Theodore Cooper (E N-Dec 5.)

Sinking Wells and Shafts. Henry Davey * (S A S-Dec 5.)

The Great Hoosac Tunnel Bore.* Theodore Cooper (R G-Dec 4.)

Stone Paving * (S-Dec.)

Disputed Points in Railway Bridge Designing (E N-Dec 12.)

Some Problems in City Engineering. L. M. Hastings (J A E S-Nov.)

Results of Tests and Experience in the Use of Low Steel (*Flusseisen*) in the Construction of the New Railway Bridges at Duschan and Marienburg, Germany.* Trans. from the German of George C. Mehrtens, by Gus C. Henning, M. E. (E M J-Dec 19.)

Seismometry and Engineering in Relation to the Recent Earthquake in Japan (N-Dec 10.)

ELECTRICAL ENGINEERING.

Distribution of Electricity at Oxford * (E R L-Nov 20.)

Electric Light Cables (El-Nov 20.)

Description of the Standard Volt and Amperemeter Used at the Ferry Works, Thames Ditton.* Capt. H. R. Frankie and F. V. Andersen (El-Nov 20.)

Woodward and Evans' Patent * (E E L-Nov 20.)

Electric Power Distribution.* H. C. Spaulding (R R-Nov 28.)

Mix and Genest's Telephone Apparatus* (E E L-Nov 27.)

The Economic Limit of Large Power Units in Electric Work.* Wm. Lee Church (E E N Y-Dec 2.)

The Measurement of the Loss by Hysteresis. Chas. Steinmetz (E E N Y-Nov 25.)

A Motor Operating Automatically at any Desired Speed and Torque and at Maximum Efficiency Under All Conditions H. Ward Leonard (W E-Nov 28.)

Practical Notes on the Reflecting Galvanometer and its Accessories.† J. D. Bishop (E R N Y-Nov 28.)

The Invention of the Microphone Transmitter.* Emile Berliner (E W-Nov 28.)

Long Distance Telephony. (Electrical Industry *m*. 30c. Chicago and New York-December.)

The First Electric Railway. Frank B. Rae (Ibid.)

Safety Devices. C. C. Haskins (E W-Dec 12.)

Larranaga's Photo-Phonograph.* Julius Mayer, Ph. D. (E L-Nov 27.)

Secondary Batteries.* G. H. Robertson, F. C. S. (E E L-Dec 4.)

Speed of Electric Cars in City Streets. Charles Hewitt * (E W-Dec 19.)

The Lighting of Residence Districts. Wm. H. Barstow (E E N Y-Dec 16.)

A Simple Method of Locating Armature Defects.* Osborne P. Loomis (E E N Y-Dec 16.)

The Electric Lighting of War Ships. Lieut. Hamilton Hutchins * (E N-Dec 5.)

The Birmingham Eng. Electric Railway. (Street Railway Journal *m*. 35c. New York and Chicago-Dec.)

The Siemens Cable Transformer* (El-Nov 27.)

Mr. Edison's Electric Railway. A Reckenzaun (E R L-Dec 11.)

Some Curves from Alternating Current Machines. Warren B. Lewis (E R L-Dec 11.)

Electrical Measurements.*† Dr. E. L. Nichols (The Crank *m*. 25c. Ithaca, N Y-Dec.)

On the Specification of Insulated Conductors for Electric Lighting and Other Purposes. W. H. Preece, F. R. S. (E E L-Dec 11.)

Electric Lighting of Cardiff (E E L-Dec 11.)

The Electric Lighting of Sidney. Prof. Therlfall (E E L-Dec 11.)

The Telephone and Aconstics (E C-Dec 16.)

ELECTRICITY—THEORETICAL.

Electricity in Relation to Time. Prof. Crookes (N-Nov 19.)

Preliminary Note on a Method for Determining the Periodic Curve of Alternating Currents. Dr. Louis Duncan (El-Nov 20.)

Researches on the Conductivity of Solid Electrolytes (E R L–Nov 20.)

On the Determination of Electric Curves. Dr. O. Frolich (El–Nov 20.)

Oscillating Magnetic Fields. Thomas Spencer (E E N Y–Dec 2.)

The Thermal Emissivity of Thin Wires in Air. W. E. Ayrton, F. R. S. and H. Kilgour (E W–Dec 19.)

Detection of Electro-Magnetic Disturbance at Great Distances. G. M. Minchin* (El–Nov 27.)

Experimental Determination of the Rate of Propagation of Electro-Magnetic Waves. R. Bloudlot (El–Nov 27.)

On the Diseharge of Electricity through Exhausted Tubes Without Electrodes.* J. J. Thomson, M. A. F. R. S. (El–Nov 27.)

HYDRAULIC ENGINEERING.

The Revolving Purifier for the Treatment of Water by Metallic Iron. Dr. W. Anderson, F. R. S. (I L–Oct 16.)

Hydraulic Machinery *† (Mechanical World *w.* 1d. Manchester, Eng–Nov 20.)

The Davy Cornish Pumping Engines at the Wolverhampton Waterworks * (I L–Nov 13.)

Description of the New Haven Water Company's Dam at Woodbridge, Conn. Lucien A. Taylor, C. E.

The Water-Works of the United States and Canada (E N–Nov 28.)

Irrigation in Egypt. Lieut.-Col. Justin C. Ross, C. M. G., Inspector General of Irrigation Egypt (I L–Nov 27.)

Three Years Experience with a Direct Pumping System. Geo. F. Chase (Journal of the New England Water Works Association. Quarterly 75c. New London, Conn–Dec.)

Are Lead Connections for Iron Service Pipes necessary? Horace G. Holder (Ibid.)

The Value of a Water Power (E N–Dec 5.)

The Growth of American Water Works (E N–Dec 5.)

Foundation of Main Dam–Periyar Project* (J E–Oct 31.)

What the Government is doing to Advance Irrigation Interests. Herbert M. Wilson. U. S. Geological Survey (E N–Dec 19.)

MARINE ENGINEERING.

The New Orient Liner "Ophir" (E–Nov 20.)

Triple Expansion Engines of H. M. S. "Naiad" *(I L–Nov 13.)

Note on the Comparison of Steam vessels. Robert Mansel (E–Nov 27.)

Steering Gear on Vessels for Lake Service.* Walter Miller, C. E. (J A E S–Oct.)

The Crosshead Pins of Large Marine Engines (I L–Nov 27.)

Official Trial of H. M. S. "Blake"* (I L–Nov 27.)

Marine Engines in the Navy. J. Jennings Campbell (Inv–Dec 5.)

The Monitor Miantonomoh (R A E G–Dec.)

The World's Columbian Exposition of 1893; the United States Navy Exhibit.* (E–Dec 11.)

The Relations of Engineering and Naval Construction (I L–Dec 11.)

MECHANICAL ENGINEERING.

Petroleum Oil-Engines. Prof. William W. Robinson, M. E. (I L–Nov 27.)

The Construction of Machine Elements* (Mechanical World *w.* 1d. London–Nov 27.)

Boiler inspection. C. A. Seley (R A–Dec 4.)

Cam Motions.* A. D. Pentz (A M–Dec 17.)

Springs and Weights. J. McKim Chase (A M–Dec. 17.)

METALLURGY.

Aluminum vs. Copper. A. Saunders Morris (E R L–Nov 27.)

The Measurement of Lenses.* Prof. Sylvanus P. Thompson, D. Sc., F.R.S. (J S A–Nov 27.)

Graphic Method of Calculating Slags.* A. J. Rossi (J A–Dec 3.)

Blast Furnace Plant—Its Equipment and Design (I A–Dec 3.)

Hoepfner's Electrolytic Process for Extracting Copper and Silver Directly from Ores (E E N Y–Dec 2.)

Austrian Tests of Mild Steel for Bridge Building* (R G–Nov 27.)

Results of Tensile and other Tests of Copper and Various Alloys.* Prof. T. Hudson Beare (I L–Dec 4.)

A Chinese System of Gold Milling.* Henry Louis, F.G.S. (E M J–Dec 5.)

MILITARY ENGINEERING.

Rees' Magazine Rifle* (E–Nov 27.)

Indian Head Armor Trials (E–Nov 27.)

Fiske's Electrical Position Finder* (E–Nov 27.)

The Government Armor Plate Tests at the Indian Head Proving Grounds* (E N–Nov 28.)

Gun Wrinkles—Shot-Guns and Rifles. G. D. Hiscox (S A S–Nov 28.)

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